4.0 SUPPORTING MATERIAL

This chapter identifies and describes habitats, including essential fish habitat (EFH) for billfishes covered by this fishery management plan (FMP) in accordance with the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act, 16 U.S.C. 1801 *et seq*.). It considers threats to EFH from fishing activities and potential threats to EFH from non-fishing activities. It identifies options for the conservation and enhancement of EFH that should be considered in the planning of projects that might adversely affect HMS EFH. These measures are representative of the conservation and enhancement measures that may be recommended by NMFS during consultation with Federal action agencies, as required by section 305(b) of the Magnuson-Stevens Act, on projects that may potentially impact HMS EFH, although specific conservation measures will be developed on a case-by-case basis. NMFS authority includes the direct management of activities associated with fishing for marine, estuarine and anadromous resources; NMFS role in Federal interagency consultations with regard to non-fishing threats is advisory. This document assumes no new authority or regulatory role for NMFS in the control of non-fishing activities beyond the statutory requirements to recommend measures to conserve living marine resources, including their habitats.

Section 303(a)(7) of the Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act (Public Law 104-297) in 1996, requires that FMPs describe and identify essential fish habitat (EFH), minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat. All existing FMPs must be amended and submitted for approval by October 11, 1998.

The Magnuson-Stevens Act provides the following definition: "Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The NMFS EFH interim final rule [62 FR 66551, December 19, 1997] (EFH regulations), provides additional interpretation of the definition of essential fish habitat: 'Waters' include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hardbottom, structures underlying the waters, and associated biological communities; 'necessary' means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and 'spawning, breeding, feeding, or growth to maturity' covers a species' full life cycle."

This chapter contains all of the required provisions as specified in the EFH regulations covering all managed species (all life stages) under this FMP for which information is available. An initial review of available literature and information was undertaken to assess habitat use of the species in the billfish fishery management unit. Published and unpublished scientific reports, fishery independent and fishery dependent data, and expert and anecdotal information were compiled and evaluated for inclusion in sections 4.3.

Impacts of HMS fishing gear and practices have been analyzed by examining published literature and anecdotal evidence of potential impacts or comparable impacts from other fisheries (section 4.4). The conclusion is that the fishing methods of the billfish fishery probably have limited impact on billfish EFH, although there is the possibility that other fisheries may adversely impact billfish EFH. This should be more closely examined and addressed through coordination with other fishery management authorities. No management measures are proposed at this time; thus, no regulations are associated with this chapter. At this time there is no evidence that billfish fishing practices are causing adverse impacts, although conservation recommendations are included to mediate the possible effects of fishing practices listed in section 4.4.

Information presented in this chapter as habitat provisions is consistent with the goals of habitat conservation. This section further serves to propose the following guidance for future NMFS actions regarding management of billfish and other HMS fishery resources:

> Recognizing that all species are dependent on the quantity and quality of their essential habitats, it is the goal of the Highly Migratory Species Division to:
>
> > Conserve, restore and improve habitats upon which commercial and recreational marine fisheries depend, to increase their extent and to improve their productive capacity for the benefit of present and future generations.
>
> This goal shall be supported by two general objectives which are to:
>
> > a. Maintain the current quantity and productive capacity of habitats supporting important commercial and recreational fisheries, through development of better understanding of the dynamics of habitat that influence biological productivity, and the pursuit of a hierarchical policy of avoidance, minimization and compensatory mitigation for actions that cause adverse effects to essential fish habitats.
> >
> > b. Restore, rehabilitate or enhance the productive capacity of habitats which have already been degraded to increased fishery productivity for the benefit of the resource and the Nation.

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Additional input was provided by the Billfish Advisory Panel through several public meetings and review of initial draft materials.

4.1 Description of stocks in the management unit

Billfishes are classified into the family Istiophoridae in the suborder Scombroidei, which also includes the swordfish (family Xiphiidae) and tunas (family Scombridae). They are epipelagic, being found primarily in the upper 300 to 600 ft (100 to 200 m) open-sea areas, and neritic, utilizing the waters over the continental shelf, and even coastal waters, seasonally. These fishes are some of the largest and fastest predators in the sea and display behavioral, anatomical, and physiological adaptions for a mobile open-sea existence.

Billfishes are distinguished by a long bill, developed as a forward growth of the upper jaw. This bill differs from that of the swordfish in that it is round rather than flat in cross section, and rough rather than smooth. At its maximum extent, it is generally less than one-quarter the total length of the fish. Billfishes capture prey fish by swimming through schools while slashing the bill back and forth, stunning or injuring the prey in the process. Marlin have also been observed knocking prey such as small tuna into the air and spearing tuna prior to swallowing them. Spearing may also be used for defensive purposes or during territorial encounters - broken bills have been found embedded in boat hulls and other objects (Moyle and Cech, Jr., 1996; Helfman *et al.*, 1997).

Billfishes move thousands of kilometers annually throughout the world's tropical, subtropical, and temperate oceans and adjacent seas. As adults and juveniles, they feed at the top of the trophic food web, meaning that their food resources are patchily distributed and occur at relatively low densities compared to prey for more generalized feeders. The foraging and movement patterns of billfishes reflect the distribution and scarcity of appropriate prey in the open seas; these species must cover vast expanses of the ocean in search of sufficient food resources (Helfman *et al.*, 1997). Consequently the distribution of billfishes is often correlated with areas where higher densities of prey are found, such as current boundaries, convergence zones, and upwelling areas.

Body shapes and physiological mechanisms of billfishes reflect the adaptations to continual and fast swimming; anatomical characteristics that are shared with other large pelagic species. They are countershaded and silvery, features which provide camouflage in the pelagic realm. These fishes have streamlined bodies, that are round or slightly compressed in cross section (fusiform), and stiff, deeply forked (lunate) tails that minimize drag. Streamlining is enhanced by depressions or grooves on the body surface into which the fins can fit during swimming. They have efficient respiration and food conversion capabilities and a high percentage of red muscle and lipids necessary for continuous and rapid swimming. Billfishes have evolved a special respiratory mode known as ram gill ventilation that is believed to conserve energy compared to the more common mechanism whereby water is actively pumped across the gills. Ram gill ventilation requires that the fish swim continuously with the mouth open while water flows across the gill surfaces, but it offers advantages in efficiency suited to the highly mobile lifestyle of the billfishes. (Helfman *et al.*, 1997).

Billfishes also exhibit physiological adaptations that enable them to extend their hunting or feeding ranges. Modified eye muscles, that have lost the ability to contract, produce heat when stimulated by the nervous system, locally warming both the brain and eye tissues. This modification allows billfishes to hunt in cold (generally deeper) water without experiencing a decrease in brain and visual function (Helfman *et al.*, 1997).

Billfishes are dioecious (the sexes are separate) with varying degrees of sexual dimorphic growth in the various species. Female are generally larger than males, although there are no morphological features or color patterns evident to differentiate the sexes. Although actual spawning has not been documented, histological (microscopic examination of ovarian tissues) studies shows it occurs seasonally. Evidence suggests that blue marlin, white marlin and sailfish spawn in the warmer months and that longbill spearfish spawn during the winter months. Reproductive females spawn more than once and probably up to four times a year; mature males are capable of spawning throughout the year (de Sylva and Breder, 1997). Based on ichthyoplankton sampling for eggs and larvae, which are rare and difficult to identify to species, spawning grounds are believed to be somewhat constant year-to-year. Fertilization is external and involves the release of millions of eggs from each female per year (e.g., a 33.4 kg. female may shed up to 4.8 million eggs in three batches during one spawning season (Jolley, 1977 in Nakamura, 1985)). Larvae tend to be fast growing, which has compounded the difficulty of identifying and characterizing each life stage.

4.2 Habitat Types and Distribution

Billfishes traverse large expanses of the world's oceans, straddling jurisdictional boundaries. Although many of the species frequent other oceans of the world, the management jurisdiction covered by the Secretarial FMPs covers Federal waters seaward of state or territorial waters, including the US Caribbean, the Gulf of Mexico and the Atlantic coast of the United States. These areas are connected by currents and water patterns that influence the occurrence of the managed species at particular times of the year. On the largest scale, the North and South Equatorial currents bathe the US Caribbean islands, before continuing through the Caribbean Basin to enter the Gulf of Mexico through the Yucatan Straits. The currents continue through the Florida Straits to join the other water masses (including the Antilles Current) to form the Gulf Stream along the eastern coast of the U.S. Variations in flow capacities of the Florida Straits and the Yucatan Straits produce the Loop Current, the major hydrographic feature of the Gulf of Mexico. These water movements in large part influence the distributions of the pelagic life stages of billfishes and other highly migratory species.

During investigation of the habitats frequented by these species, various habitats were identified as essential to these species. Billfish distributions are most frequently associated with hydrographic features such as density fronts between different water masses. The scales of the features vary. For example, the river plume of the Mississippi River extends for miles into the Gulf of Mexico and is a fairly predictable feature, depending on the season. Fronts that set up over the De Soto Canyon in the Gulf of Mexico, or over the Charleston Bump or the Baltimore Canyon on the mid-Atlantic shelf may be of a much smaller scale. The locations of many fronts or frontal features are statistically consistent within broad geographic boundaries (see Figure 4.3.2a). These locations and the habitat characteristics are influenced by riverine inputs, movement of water masses and the presence of topographic structures underlying the water column, thereby influencing the habitat of billfishes.

In determining EFH for billfishes, consideration has been given to habitat associations for all life stages. Though they typically range throughout open ocean waters, many billfishes also move inshore, at some time during their life cycles. Associations with particular bottom types are undefined, and this lack of information has been identified as an important research need (Section 6.5). Because of the periodic use of these inshore habitats, in addition to open ocean habitats, inshore areas and estuaries are described in terms of distribution, size, depth, freshwater inflows and habitat types (e.g., bottom types) available. As additional information is accumulated, this section will be expanded to more fully characterize the links between the managed species and specific habitat characteristics. The following sections describe the distribution of the habitats that are utilized by these species, including those that are considered to be EFH. They include descriptions of the features of the continental shelf/slope and the dominant current patterns in-so-far as they may influence the existence and persistence of hydrographic fronts. Much of the information originally appeared in previous documents (MMS 1992, MMS 1996, NOAA 1991, NOAA 1992, NOAA 1997a, NOAA 1997b, NOAA 1997c; and NOAA 1997d).

4.2.1 Atlantic

For management of billfishes, the Atlantic region of the Federal jurisdiction spans the area between the Canadian border in the north and the Dry Tortugas in the south. This region includes a diverse spectrum of aquatic species of commercial, recreational, and ecological importance. The distribution of marine species along the Atlantic seaboard is strongly affected by the cold Labrador Current in the northern part, the warm Gulf Stream in the middle and southern portions of the region and the combination of high summer and low winter temperatures.

Cape Hatteras forms a fairly strong zoogeographic boundary to many species off the Atlantic coast between the mid- and south Atlantic areas and the Cape Cod/Nantucket Island area is a somewhat weaker zoogeographic boundary in the north. Considering the region as a whole, it is clear that there are four fairly distinct biological regimes:

1) Arcadian/Scotian Province - from the Canadian border (jurisdictionally) to just south of Cape Cod (north Atlantic);
2) Virginian Transition Province - from Cape Cod to Cape Hatteras;
3) Carolinian Province - Cape Hatteras to just south of Cape Canaveral; and
4) **Floridian/Caribbean Province** - just north of Miami to the Dry Tortugas.

For the purposes of this document, we will divide the Atlantic region into three zones - North Atlantic, Mid-Atlantic and South Atlantic - for general descriptions of habitats, combining regimes 3 and 4 above. The boundaries between these zones are fluid and do not limit either the movement of the highly migratory billfishes or the water masses that flow through the region. All of these provinces have resident and migratory species that make up the complex fish assemblages. The mid-Atlantic area from Cape Cod to Cape Hatteras represents a transition zone between northern cold-temperate waters of the north and the warm-temperate waters to the south. Water temperatures in the mid-Atlantic vary greatly by season. Consequently, many of the fish species of importance in the mid-Atlantic area are seasonal migrants, whereas the major species in the other three areas are typically resident.

4.2.1.1 Continental Shelf/Slope Features.

North Atlantic Shelf Features. The circulation patterns of the Gulf of Maine and Georges Bank dominate the oceanographic regime of the northeastern Atlantic shelf. The Gulf of Maine is a deep indentation in the continental shelf with irregular bottom topography. Its bottom consists of three major basins and many smaller ones separated by numerous ridges and ledges. It is a semi-enclosed sea with Nova Scotia as its northern and eastern boundary and the northeastern U.S. coast as its western boundary. Georges and Browns Banks significantly separate the Gulf of Maine from the Atlantic Ocean.

Georges Bank is a large, relatively shallow topographic high that lies southeast of the Gulf of Maine. The bank's seaward edge comprises part of the shelf break in the north Atlantic. Georges Bank is consistently one of the most productive habitats for plankton in the world. The tidal and oceanographic current regimes in the area and Georges Bank's proximity to deep slope water allow upwelling events to occur that transport nutrient rich deep water to the shallow, euphotic areas of the bank. This provides increased primary productivity that benefits higher trophic level fish and shellfish species. On the seaward side, Georges Bank is cut by numerous submarine canyons. The outcroppings and hardened sediments of the canyons provide increased attachment substrate for deeper-water epifaunal organisms and allow complex faunal communities to form.

From the Scotian Shelf in the north, past Georges Bank and through the Mid-Atlantic Bight, a shelf-slope front exists. This hydrographic boundary separates the fresher, colder, and more homogeneous waters of the shelf and the horizontally stratified, warmer, and more saline waters of the continental slope. The shelf-slope front may act as a barrier to shelf-slope transfer of water mass and momentum. Exchange of water masses occurs primarily at small scales.

From Nova Scotia to Cape Hatteras, 26 large valleys which originate on the shelf cut into the seafloor downward across the slope and rise. The current regimes in these submarine canyons promote significant biological productivity and diversity. Tidal oscillations on the shelf combined with the intermittent influence of Gulf Stream warm core rings on the slope dominate currents and influence sediment transport in the canyons. Current measurements show that the canyon topography directs the mean shelf current below 100 m (328 ft) into the canyon rather than along the shelf break. Peak currents occur near the canyon heads and flow down the canyon while currents at intermediate depths flow up the canyon. These patterns suggest a circulation that may trap sediments in the canyon heads and produce conditions conducive to front development. Billfish aggregate in the areas where these fronts form, most likely as productive feeding grounds.

On the north and mid-Atlantic continental slope and rise the epifauna is controlled by a combination of depth and topography (canyon versus slope gradient). Whereas on the south Atlantic slope and rise, the epifauna appears to be controlled by a more complex oceanographic system dominated by a current regime which includes the Gulf Stream and Western Boundary Undercurrent and by a greater diversity of substrata.

Mid-Atlantic Shelf Features. The mid-Atlantic region is between the colder, arctically influenced environments to the north and the warm, sub-tropical systems to the south. This area reflects a transition zone between the glacial till, rocky shores and steep gradients of the New England states and the wide, gently sloping geology of the coastal plains of the southeastern US. The mid-Atlantic is a highly diverse, often seasonally-utilized zone for many aquatic and terrestrial species. Billfishes, notably white marlin and sailfish, move into or through this zone during the warmer seasons of the year. A major biogeographic boundary for marine organisms on the continental shelf occurs at Cape Hatteras where the Gulf Stream turns eastward, separating the temperate and tropical provinces. A sharp faunal break is less obvious on the slope although this area does appear to be a region of rapid faunal change.

The mid-Atlantic shelf is relatively flat, but there is a ridge-and-swale (hill-and-valley) topography that may be a result of present oceanographic conditions or remnant barrier beaches.

The shelf typically is covered by thin layer of poorly-sorted shell and medium-to-coarse grained sand that overlays clay sediments. In general, the surface sediments grade from medium-grained sands inshore to finer sediments at the shelf break. Coarse-grained sediments generally support large quantities of animals, including many sessile forms. Fine-grained sediments usually contain a depauperate fauna and attached organisms are uncommon. Within the Mid-Atlantic Bight, the quantity of fauna decreases markedly from north to south and from shallow to deep water.

The six major submarine canyons - Block, Hudson, Wilmington, Baltimore, Washington, and Norfolk Canyons - occur within 150 km of shore. They begin in waters of little more than 100 to 200 m (325-650 ft) and descend to 2,000 m (6500 ft.). Numerous smaller submarine canyons, V-shaped valleys that resemble land canyons of fluvial origin, cut the continental slope along the Atlantic coast. Canyons become less rugged and numerous to the south with the last significant one, Norfolk Canyon, occurring off Chesapeake Bay.

Canyon topography tends to be rugged and diverse, with numerous outcrops providing a greater amount of substrate for faunal attachment than is typically found along the rest of the continental margin. Submarine canyons also appear to act like terrestrial watersheds, concentrating water, sediments, and dissolved and particulate nutrients which flow off the shelf. This characteristic can tend to increase the zone of influence of estuarine and coastal activities into shallow or deep shelf waters, potentially affecting the quality of billfish EFH. The heterogeneity of canyon environments results in communities that are generally richer biologically than those on the adjacent shelf and slope. Additionally, the species assemblages inhabiting the head, axis, and lower walls of large submarine canyons are frequently different from those found on the continental slope. Canyon assemblages are often dominated by large populations of sessile filter feeders, but slope assemblages usually consist of sparse mobile carnivore/scavenger populations.

South Atlantic Shelf. The south Atlantic continental shelf area can be divided into five types of habitat: coastal, open shelf, live-bottom, shelf-edge, and upper continental slope. Each of these types has its own distinctive characteristics and species assemblages.

The **coastal habitat** has a smooth sandy-mud bottom and is usually shallower than 20 m (66 ft). The **open shelf habitat** is found between about 20 and 55 meters (66 and 180 ft) and has a smooth sandy substrate. This habitat predominates between the occasional live-bottom areas on the outer shelf. Typically, these are areas of relatively low productivity. **Live-bottom habitats**, although sporadically distributed, are areas of high productivity and are usually found in water depths of approximately 20 to 55 m (66 to 180 ft). The exposed hard substrate in these areas has allowed colonization by many attached species, such as soft corals, and provides three dimensional space (habitat) for many species, some of which are prey for billfish. The complexity and average vertical relief of these live-bottom areas typically increase seaward. These live-bottom areas provide habitat for the warm water snapper-grouper assemblage of fishes. The **shelf-edge habitat** may range in water depth between 40 and 100 m (131 and 328 ft). The bottom topography varies from smooth sand to mud to areas of high relief with associated corals and sponges. The fish species found in this area include parrotfish (Scaridae) and the deepwater species of the snapper-grouper. Many juveniles of certain species of fish are found in *sargassum* overlying this habitat, but the fate of these juveniles is unknown. The last category in the south Atlantic, the upper **continental slope habitat**, has smooth mud bottoms in water depths of 100 to 200 m (~325 to 660 ft). Many of the species in this zone are representatives of cold water northern species exhibiting tropical submergence (i.e., being located in deeper, cooler water as latitude decreases).

A similar pattern of hard and soft bottom habitats interspersed in a complex mosaic occurs in the southern part of the Atlantic (Miami to the Dry Tortugas). The Florida shelf is a limestone platform which is exposed in some areas and covered with quartz and carbonate sands in others. Offshore hard bottom habitats usually consist of rock covered by a thin, mobile, sand veneer. These areas are usually colonized by a diverse biota of tropical and temperate species, including macroalgae, stony corals, soft corals, sponges, and bivalves. Overall, about 30 percent of the southwest Florida shelf consists of live bottom areas. In addition, this area contains most of the true coral reefs, and their associated fauna, found in North America. The coral reef areas are highly diverse habitats with complex three-dimensional space and relatively high biological productivity.

Live-bottom habitats, small isolated areas of broken relief consisting of rock outcroppings that are heavily encrusted with sessile invertebrates, are scattered over the shelf. These habitats, although sporadically distributed, are areas of high productivity and are usually found in water depths between 20 and 55 m (66-180 ft.). In shallower water, live-bottom areas are usually dynamic because water currents can transport the surficial sand layer and cover existing communities or expose new hard bottoms for colonization. The deeper water live-bottom areas tend to be more stable. Thus, the complexity and average vertical relief of these live-bottom areas typically increase in the seaward direction. In addition to these live-bottom communities, extensive banks of coral occur on the Blake Plateau at depths between 650 and 850 m (~2100-2800 ft.). Along the shelf-edge, water depths average between 40 and 100 m (130-325 ft). The bottom topography varies from smooth mud to areas of high relief with associated encrusting corals and sponges. The lower-shelf habitat has smooth mud bottoms in water depths between 100 and 200 m (~325 and 660 ft).

A topographic irregularity southeast of Charleston, South Carolina, known as the Charleston Bump, is an area of productive sea floor which rises abruptly from 700 m (2300 ft.) to 300 m (980 ft.) within a distance of about 20 km, and at an angle which is approximately transverse to both the general isobath pattern and the Gulf Stream currents. The Charleston Gyre is a persistent oceanographic feature that forms in the lee of the Charleston Bump. It is a location from which larval swordfish have been commonly found and may serve as nursery habitat for other billfish as well.

Deepwater banks occur predominantly beyond the outer edge of the continental shelf on the continental slope. Although their distribution is still being delineated, these structures have been identified in the western south Atlantic region, especially within Bahamian national waters, and have been reported in the Straits of Florida off Little Bahama Bank. Some do occur near the outer edge of the EEZ. The banks are composed of lithified sandy carbonate sediments supporting a regionally diverse array of benthic fauna, with ahermatypic branching corals as the chief contributors to structure and habitats.

4.2.1.2 Physical Oceanography (Water Movements and Marine Habitats).

The shelf area of the Mid-Atlantic Bight averages about 100 km (~60 mi) in width, reaching a maximum of 150 km (~90 mi) near Georges Bank and a minimum of 50 km (~30 mi) offshore Cape Hatteras. The mean current flow is alongshelf and to the southwest, interspersed with localized areas where outflow from major estuaries (i.e., Connecticut River, Lower New York Bay, Delaware Bay, and Chesapeake Bay) interrupts the flow field. Current speeds are strongest at the narrowest part of the shelf where wind-driven current variability is highest. The slope area is influenced by the presence of the western Slope Sea Gyre, which is present 85 percent of the time with a relatively strong net southeastward flow along the New Jersey coast.

In the high northern latitudes, North Atlantic Deep Water (NADW) flows southward out of the Norwegian Sea and into the Labrador Sea forming the Deep Western Boundary Current (DWBC) (also known as the Western Boundary Undercurrent). After taking a counterclockwise course through the Labrador Sea, the DWBC flows around the Grand Banks of Newfoundland and then follows the topography of the U.S. Atlantic slope. It passes under the Gulf Stream near Cape Hatteras and continues into the South Atlantic. Meanders of the DWBC core account for variations in velocity and volume transport according to measurements in the Blake Plateau region.

The continental shelf in the South Atlantic Bight varies in width from 50 km (32 mi) off Cape Canaveral, FL to a maximum of 120 km (75 mi) off Savannah, Georgia and a minimum of 30 km (19 mi) off Cape Hatteras. The shelf can be divided into three cross-shelf zones. Waters on the inner shelf (O to 20 m [O to 66 ft]) interact extensively with rivers, coastal sounds, and estuaries. This interaction tends to form a band of low-salinity, stratified water near the coast that responds quickly to local wind-forcing and seasonal atmospheric changes. Mid-shelf (20 to 40 m [66 to 130 ft]) current flow strongly correlates to local wind events with frequencies of 2 days to 2 weeks. In this region, vertically well mixed conditions in fall and winter contrast with vertically stratified conditions in the spring and summer. Gulf Stream frontal disturbances (i.e., meanders and cyclonic cold core rings) that occur on time scales of 2 days to 2 weeks dominate currents on the outer shelf (40 to 60 m [132 to 197 ft]).

The Gulf Stream produces periodic meanders, filaments, and warm and cold core rings that significantly affect the physical oceanography of the continental shelf and slope and can influence the distribution of billfish. This western boundary current has its origins in the tropical Atlantic Ocean (i.e., the Caribbean Sea). The Gulf Stream system is made up of the Yucatan Current that enters the Gulf of Mexico through the Yucatan Straits; the Loop Current which is the Yucatan Current after it separates from Campeche Bank and penetrates the Gulf of Mexico in a clockwise flowing loop; the Florida Current, as it travels through the Straits of Florida and along the continental slope into the South Atlantic Bight; and the Antilles Current as it follows the continental slope (Bahamian Bank) northeast to Cape Hatteras. From Cape Hatteras it leaves the slope environment and flows into the deeper waters of the Atlantic Ocean.

The flow of the Gulf Stream as it leaves the Straits of Florida is jet-like with maximum speeds at the surface that are usually about 200 cm/s. During strong events, maximum current speeds greater than 250cm/s have been recorded offshore of Cape Hatteras. The width of the Gulf Stream at the ocean surface ranges from 80 to 100 km (50 to 63 mi) and extends to depths of between 800 and 1,200 m (2624-3937 ft).

Meandering events of the Gulf Stream are caused by atmospheric forcing or bathymetric features (e.g., the Charleston Bump). Meanders are lateral oscillations of the mean current stream (flow field) produced by migrating waves. They may affect the location of the Gulf Stream's western boundary and have amplitudes (east-west displacement) of up to 25 km (15.5 mi)off the coast of Florida and Georgia. However, north of the Charleston Bump, the amplitude may increase to about 100 km (63 mi). Meanders occur periodically in the 2- to 15-day range.

As a meander passes, the Gulf Stream boundary oscillates sequentially onshore (crest) and offshore (trough). A meander can cause the Gulf Stream to shift slightly shoreward or well offshore into deeper waters. The Gulf Stream behaves in two distinct meander modes (small and large), with the size of the meanders decreasing as they move northward along the coast. During the large meander mode, the Gulf Stream front is seaward of the shelf break, with its meanders having large amplitudes. Additionally, frontal eddies and accompanying warm-water filaments are larger and closer to shore. During the small meander mode, the Gulf Stream front is at the shelf break. Frontal eddies and warm-water filaments associated with small amplitude meanders are smaller and farther from shore. Since billfish tend to follow the edge of the Gulf Stream, their distance from shore can be greatly influenced by the patterns of meanders and eddies.

Meanders have definite circulation patterns and conditions superimposed on the statistical mean (average) condition. As a meander trough migrates in the direction of the Gulf Stream's flow, it upwells cool nutrient-rich water, which at times may move onto the shelf and may evolve into an eddy. These boundary features move south-southwest. As warm-water filaments, they transfer momentum, mass, heat, and nutrients to the waters of the shelf break.

Gulf Stream filaments are mesoscale events which occur regularly offshore the southeastern United States. The filament is a tongue of water extending from the Gulf Stream pointing to the south. They form when meanders cause the extrusion of a warm-surface filament of Gulf Stream water onto the outer shelf. The cul-de-sac formed by this extrusion contains a cold core that consists of a mix of outer-shelf water and nutrient-rich water. This water mix is a result of upwelling as the filament/meander passes along the slope. The period from genesis to decay is typically about 2 to 3 weeks.

The Charleston Gyre is a permanent oceanographic feature of the South Atlantic Bight, caused by the interaction of rapidly moving Gulf Stream waters with the topographically irregular Charleston Bump. The gyre produces an upwelling of nutrients, which contributes significantly to primary and secondary productivity of the Bight, and is thus important to some ichthyoplankton, including swordfish. The degree of upwelling varies with the seasonal position and velocity of the Gulf Stream currents.

In the warm waters between the western edge of the Florida Current/Gulf Stream and 20° N and 40° N latitude, pelagic brown algae, *Sargassum natans* and *S. fluitans*, form a dynamic structural habitat. The greatest concentrations are found within the North Atlantic Central Gyre in the Sargasso Sea. Large quantities of *Sargassum* frequently occur on the continental shelf off the southeastern U.S. Depending on prevailing surface currents, this material may remain on the shelf for extended periods, be entrained into the Gulf Stream, or be cast ashore. During calm conditions, *Sargassum* may form irregular mats or simply be scattered in small clumps. Oceanographic features such as internal waves and convergence zones along fronts aggregate the algae along with other flotsam into long linear or meandering rows collectively termed “windrows”.

Pelagic *Sargassum* supports a diverse assemblage of marine organisms including fungi, micro- and macro-epiphytes, sea turtles, numerous marine birds, at least 145 species of invertebrates, and over 100 species of fishes. The fishes associated with pelagic *Sargassum* include juveniles as well as adults, including large pelagic adult fishes. Billfishes are among those that can be found at different life stages associated with sargassum. The *Sargassum* community, consisting of the floating *Sargassum* (associated with other algae, sessile and free-moving invertebrates, and finfish) is important to some epipelagic predators such as wahoo and dolphin. The *Sargassum* community provides food and shelter from predation for juvenile and adult fish, and may have other functions such as habitat for fish eggs and larvae.

Offshore water quality in the Atlantic is controlled by oceanic circulation. Oceanic circulation is dominated by the Gulf Stream and by oceanic gyres in the mid-Atlantic. A shoreward, tidal and wind-driven circulation dominates as the major cause of pollutant transport between estuaries and the nearshore. Water quality in nearshore water masses adjacent to estuarine plumes and in water masses within estuaries is also influenced by density-driven circulation. Suspended sediment concentration can be used as an indication of water quality. For the Atlantic coastal areas, suspended sediment concentration varies with respect to depth and distance from shore. The variability is greatest in the mid-Atlantic and south Atlantic. Resuspended bottom sediment is the principal source of suspended sediments in offshore waters.

4.2.1.3 Coastal Habitats

Billfishes are known to range offshore as far north as Georges Bank. Although they move primarily throughout open-ocean waters, two species, the white marlin and the sailfish can be found inshore. Sailfish move inshore to spawn off the east coast of Florida and in the Florida Keys. Coastal habitats that might be utilized by sailfish and other billfish will be briefly described in this section. It should be noted that habitat characteristics of coastal and offshore habitats may be affected by activities and conditions occurring outside of those areas (farther up-current) due to water flow or current patterns, e.g., by riverine inflows or longshore currents, that may transport materials that cause negative impacts.

A great diversity of shoreline types is found along the Atlantic coast. Much of the ocean frontage along Cape Cod and from Long Island to southern Florida consists of sandy beach-dunes and/or barrier beach areas. These barriers are separated in the north by broad estuaries and in the south by narrow, shallow lagoons. At the southern tip of Florida and along the Florida Keys, swamps and mangroves are the dominant shoreline features. Mudflats exist along the shores of many of the bays and sounds. In addition, there are localized sections of dense shoreline development (USDOC, NOAA, 1980b; CSA, 1990).

Beaches are particularly important for providing protection from storms, high tides, and wave action for the lagoons, sounds, wetlands, and low ground located landward of them. Natural dune areas found landward of sandy beaches often support seabirds, shorebirds, waterfowl, and a dune grass or shrub community. The ecologically fragile dune grass or shrub communities are important for maintaining beach and dune stability and are particularly intolerant of pollution or beach development. Mudflats, swamps, and mangroves occur in areas of low wave energy. These areas tend to act as sediment sinks, trapping nutrients that support a variety of plants, fish, birds, and mammals; they also trap and sequester pollutants.

The coastal ocean is a shallow, nutrient-rich, and productive environment. Longshore currents advect sediments (and nutrients) parallel to the typically north-south running shoreline and are a primary cause of the elongate barrier islands and narrow inlets common in this region. The numerous inlets and other passageways for exchange between the estuarine and oceanic waters provide an important conduit between systems for a diverse suite of living marine resources, many of which spend significant portions of their lives in either medium, or require a specific habitat type for growth and development during a specific life stage. The opportunity for movement between two very different systems contributes greatly to the biological productivity and, thus, the commercial importance of the mid-Atlantic coast.

Sediments in the coastal zone are often coarse-grained compared with estuarine and outer continental shelf sediments. Wave action nearshore tends to segregate size fractions within the coastal zone such that a seaward fining of particles occurs from the beach face to the offshore areas. Deviation from this pattern often occurs at the mouths of major river valley estuaries where the outflow plume often deposits fine-grained silts and clays in the nearshore zone. Typical inshore sediments are a mixture of quartz particles and those of biogenic origin (i.e. shell fragments) until finer grains are encountered offshore.

The coastal zone is generally highly energetic; as offshore swells and waves begin to "feel" the bottom, crest and break at the beach face. Storm energy is often concentrated in this zone as waves generated far offshore finally release their large amounts of latent power. This energy is often converted to strong currents which can carry large sediment loads and can erode shorelines and destroy man-made structures rapidly. Without hard structure for attachment, as is common in the mid-Atlantic, many sessile organisms cannot live in this environment. However, a number of attached animals find suitable substrate on man-made objects such as pilings and revetments, and many benthic filter-feeding organisms thrive in the rapid transfer of nutrients.

4.2.2 Gulf of Mexico

The Gulf of Mexico supports a great diversity of fish resources that are related to variable ecological factors, such as salinity, primary productivity, bottom type, etc. These factors differ widely across the Gulf of Mexico and between the inshore and offshore waters. Characteristic fish resources are not randomly distributed; high densities of fish resources are associated with particular habitat types (e.g., east Mississippi Delta area, Florida Big Bend seagrass beds, Florida Middle Grounds, mid-outer shelf, and the De Soto Canyon area). The highest values of surface primary production are found in the upwelling area north of the Yucatan Channel and in the De Soto Canyon region. In terms of general biological productivity, the western Gulf is considered more productive in the oceanic region than is the eastern Gulf. Productivity of billfish resources varies between the east and west Gulf depending on the influence of the Loop Current.

4.2.2.1 Continental Shelf/Slope Features.

The Gulf of Mexico is a semi-enclosed, subtropical sea with a surface area of approximately 1.6 million km^2. The main physiographic regions of the Gulf basin are the continental shelf (including the Campeche, Mexican, and U.S. shelves), continental slopes and associated canyons, the Yucatan and Florida Straits, and the abyssal plains. The continental shelf width along the U.S. coastline reaches a minimum of 16 km (9.9 m) off the Mississippi River, and evidence suggests that the river outflow effectively splits the shelf into the Texas-Louisiana western province and the Mississippi-Alabama-Florida eastern province. The continental shelf width varies significantly from about 217 mi (350 km) offshore west Florida, 97 mi (156 km) off Galveston, Texas, decreasing to 55 mi (88 km) off Port Isabel near the Mexican border. The depth of the central abyss ranges to 13,000 ft (4,000 m). The Gulf is unique among mediterranean seas because it has two entrances: the Yucatan Strait and the Straits of Florida. The Gulf's general circulation is dominated by the Loop Current and its associated eddies caused by differences between the sill depths of the two straits. Coastal and shelf circulation on the other hand is driven by several forcing mechanisms: wind stress, freshwater input, buoyancy and mass fluxes, and transfer of momentum and energy through the seaward boundary.

The physiographic provinces in the Gulf of Mexico--shelf, slope, rise, and abyssal plain--reflect the underlying geology. In the Gulf, the continental shelf extends seaward from the shoreline to about the 200-m water depth and is characterized by a gentle slope of less than one degree. The continental slope extends from the shelf edge to the continental rise, usually at about the 6500 ft (2,000 m) water depth. The topography of the slope in the Gulf is uneven and is broken by canyons, troughs, and escarpments. The gradient on the slope is characteristically 1-6 degrees, but may exceed 20 degrees in some places, particularly along escarpments. The continental rise is the apron of sediment accumulated at the base of the slope. The incline is gentle with slopes of less than one degree. The abyssal plain is the basin floor at the base of the continental rise.

Texas/Louisiana Shelf Features. The shelf and shelf edge of the central and western Gulf are characterized by topographic features that are inhabited by hard-bottom benthic communities. The habitats created by the topographic features is important in several respects: it supports hard-bottom communities of high biomass, high diversity, and high numbers of plant and animal species; and, it supports as shelter and/or food, large numbers of recreational and commercially important fishes. These habitats are unique to the extent that they are small, isolated areas within vast areas of much lower diversity; they are relatively pristine areas (especially the East and West Flower Garden Banks); and they have an aesthetically attractive intrinsic value. The benthic organisms (primarily corals) that contribute to the relief of these features are mainly limited by temperature and light. Although corals will grow or survive under low light level conditions, they do best while submerged in clear, nutrient-poor waters. Light penetration in the Gulf is limited by several factors including depth and events of prolonged turbidity. Hard substrate favorable to colonization by coral communities in the northern Gulf is found on outer shelf, high relief features.

Because midshelf banks experience less light penetration and colder temperatures, the biota differs significantly from outer shelf banks. Instead of the high diversity coral reef-building zone found at the Flower Gardens (outer shelf), the midshelf banks tend to be dominated by zones of minor reef building activity, e.g., Sonnier Bank, Stetson Bank, and Claypile Bank. Claypile Bank, with only 10 m of relief, is considered a low-relief bank and is often enveloped by the nepheloid layer. Thus, the level of biological community development (the Millepora-sponge community) is lowest at Claypile Bank. Two other midshelf banks, 32 Fathom Bank and Coffee Lump, have reliefs less than 10 m and are also considered to be low-relief banks. Geyer Bank, which crests at 37 m (within the depth that the high-diversity coral reef zone would be expected), does not contain a coral reef; only minor reef building has occurred.

The south Texas banks are geologically distinct from the shelf edge banks. Several of the south Texas banks are low-relief banks, have few hard-substrate outcrops, exhibit a reduced biota, and have a thicker sediment cover than the other banks. Sebree Bank is a low-profile feature located in 36.5 m (120 ft) of water. The highest area of the bank is about 31 m (102 ft) deep. The bank appears composed of large boulders mostly veneered by fine sediments. The low relief of the bank and the fine sediments covering the bank indicate that Sebree Bank frequently exists in turbid conditions. The biota of the bank appears sparse due to these conditions. The bank attracts abundant nektonic species that utilize the overlying water column.

Eastern Gulf Shelf Features. Although the Gulf off Florida does not contain any of the topographic features common to the offshore areas off Texas and Louisiana, Florida offshore waters do contain several offshore habitats of particular note which can be characterized as live-bottom.

The **"pinnacle trend"** can be found in the waters south-southwest of Mobile Bay between 67- and 110m (220 and 360 ft). The pinnacles appear to be carbonate reef structures in an intermediate stage between growth and fossilization. These features may have been built during periods of lower sea level and during the rise in sea level following the most recent ice age. The pinnacles provide a large amount of surface area for the growth of sessile invertebrates and attract large numbers of fish.

The pinnacles are found at the outer edge of the Mississippi/Alabama shelf between the Mississippi River and the De Soto Canyon. The bases of the pinnacles rise from the seafloor between 50 and 100 m with vertical relief of 20 m. These pinnacles may also provide structural habitat for a variety of pelagic fish and their prey.

The northwest Florida shelf is dominated by sand-bottom assemblages with low-relief, low-diversity communities widely interspersed with carbonate outcroppings. These outcroppings occasionally serve as attractors for hard-bottom biota and large aggregations of small fish.

Live bottoms are regions of high productivity characterized by a firm substrate with high diversity of epibiota. These communities are scattered across the west Florida shelf in the shallow waters with depth zonation apparent, and within restricted regions off Louisiana, Mississippi, and Alabama. The density of the epibiotal communities varies from sparse to 100 percent coverage of the bottom and is largely depending on bottom type, current regimes, suspended sediments, habitat availability, and anthropogenic perturbations. Sessile epibiota include seagrasses, algae, sponges, anemones, encrusting bryozoans, and associated communities. For the purposes of this document, live bottoms also include rocky formations with rough, broken, or smooth topography.

The **Florida Middle Ground** is probably the best known and most biologically developed of the eastern Gulf live bottoms, with extensive inhabitation by hermatypic (reef building) corals and related communities. This area is 160 km (99 mi) west-northwest of Tampa and has been designated as a Habitat Area of Particular Concern (HAPC) by the Gulf of Mexico Fishery Management Council (50 CFR 638). Bottom longlines, traps and pots, and bottom trawls are prohibited within the HAPC. The taking of any coral is prohibited except as authorized by permit from NMFS.

The Florida Middle Ground represents the northernmost extent of coral reefs and their associated assemblages in the eastern Gulf. The Middle Ground is similar to the Flower Garden Banks off Texas (typical Caribbean reef communities) although with a reduced number of species present, probably because it is nearer the northern limit of viable existence for these types of coral communities. In the Caribbean, reefs may grow as deep as 80 m (260 ft), while in the Gulf they seem to be limited to a depth of about 40 m (130 ft). The Middle Ground reefs rise essentially from a depth of 35 m (115 ft), and the shallowest portions are about 25 m (80 ft) deep. The Florida Middle Ground supports numerous Caribbean fish, coral, and other invertebrate species. This is probably due to the intrusion of the Loop Current, short periods of low temperatures, and high organic productivity.

The southwest Florida shelf, in water depths between 10 and 200 m (33-660 ft), has been characterized into several biological assemblages that are associated with particular substrates and depths. Although depth is probably not the decisive factor in determining the distribution of the biotic assemblages, three major biotic depth zones are evident. There appears to be an innershelf zone between 10 and 60 m (33-197 ft) water depths, a transitional zone between 60 and 90m (197-297 ft), and an outer-shelf zone from 90 to 200 m (297-660 ft). A brief description of each assemblage can be found in the Gulf of Mexico Council's EFH amendment.

The **Florida Keys** comprise an important shallow-water, tropical, coral-reef ecosystem that is unique on the continental shelf of North America. The coral reefs of the Keys are vital to the economy of Florida. Commercial and recreational fishing, as well as non-consumptive uses such as boating, scuba diving, snorkeling, and educational and natural history activities are economically important. The Florida reef tract is the only shallow-water tropical coral reef ecosystem found on the continental shelf of North America. The Florida Keys archipelago, extending from Soldier Key to the Dry Tortugas, exhibits a diverse array of hardgrounds, patch reefs, and bank reefs from nearshore to 13 km (8 mi) offshore.

Patch reefs are the principal reef form between Elliott Key and Key Largo, where approximately 5,000 patch reefs are found. Patch reefs typically occur in water depths of about 2 to 9 m (6.6-30 ft). Bank reefs occur 7.4 to 13 km seaward of the Keys, paralleling the coast. Most occur off Key Largo and from Big Pine Key to Key West where major islands protect the reefs from the detrimental influence of Florida Bay waters. A reef flat is located on the inshore side of bank reefs. The deepest portions of Florida bank reefs are in 37-40m (121-132 ft) depths and occur as isolated outcrops surrounded by sediments. The Dry Tortugas is composed of islands, shoals, and reefs located about 117 km (73 mi)west of Key West.

4.2.2.2 Physical Oceanography (Water Movements and Marine Habitats).

The Gulf receives large amounts of freshwater runoff from the Mississippi River as well as from a host of other drainage systems. This runoff mixes with the surface water of the Gulf, making the nearshore water chemistry quite different from that of the open ocean. Sea surface salinities along the northern Gulf vary seasonally. During months of low freshwater input, salinities near the coastline range between 29 to 32 parts per thousand (ppt). High, freshwater input conditions during the spring and summer months result in strong horizontal gradients and inner shelf salinities less than 20 ppt. The mixed layer in the open Gulf, from the surface to a depth of approximately 100 to 150 m (330-495 ft), is characterized by salinities between 36.0 and 36.5 ppt.

Sharp discontinuities of temperature and/or salinity at the sea surface, such as the Loop Current front or fronts associated with eddies or river plumes, are dynamic features that may act to concentrate buoyant material such as spilled oil, detritus, plankton or eggs and larvae. These materials are transported, not by the front's movements or motion across the front, but mainly by lateral movement along the front. In addition to open ocean fronts, a coastal front, which separates turbid, lower salinity water from the open-shelf regime, is probably a permanent feature of the northern Gulf shelf. This front lies about 30-50 km offshore. In the Gulf, these fronts are the most commonly utilized habitat of the pelagic billfish species.

The Loop Current is a highly variable current entering the Gulf through the Yucatan Straits and exiting through the Straits of Florida (as a component of the Gulf Stream) after tracing an arc that may intrude as far north as the Mississippi-Alabama shelf. The current has been detected down to about 1000m below the surface. Below that level there is evidence of a countercurrent. The "location" of the Loop Current is definable only in statistical terms, due to its great variability. Location probabilities during March, the month of greatest apparent intrusion, range from 100 percent in the core location at 25° N latitude, down to small probabilities (10%) near midshelf. Analysis has indicated an average northern intrusion to 26.6° N latitude, within a wide envelope.

When the Loop extends into or near shelf areas, instabilities, such as eddies, may develop that can push warm water onto the shelf or entrain cold water from the shelf. These eddies consist of warm water rotating in a clockwise fashion. Major Loop Current eddies have diameters on the order of 300 to 400 km (186-249 mi) and may extend to a depth of about 1000 m. Once these eddies are free from the Loop, they travel into the western Gulf along various paths to a region between 25° N to 28° N latitude and 93° W to 96° W longitude. As eddies travel westward, a decrease in size occurs due to mixing with resident waters, and friction with the slope and shelf bottoms. The life of an individual eddy to its eventual assimilation by regional circulation in the western Gulf is about 1 year. Along the Louisiana/Texas slope, eddies are frequently observed to affect local current patterns hydrographic properties, and possibly the biota of fixed platforms or hard bottoms. Once an eddy is shed, the Loop undergoes major dimensional adjustment and reorganizations.

Small anticyclonic (clockwise) eddies are also generated by the Loop Current. They have diameters on the order of 100 km (62 mi), and the few data available indicate a shallow vertical extent (ca. 200 m or 660 ft). These smaller eddies have a tendency to move westward along the Louisiana/Texas slope. Also, cyclonic (counterclockwise) eddies associated with the larger scale eddy process have been observed in the eastern Gulf and the Louisiana/Texas slope. Their origin and role in the overall circulation are presently not well understood. A major eddy seems to be resident in the southwestern Gulf, however, recent evidence points toward a more complex, and less homogeneous structure.

Shelf circulation is complicated because of the large number of forces and their variable seasonality. A northward current driven by prevailing winds and the semipermanent anticyclonic eddy exist offshore of south Texas. A strong east-northeasterly current along the remaining Texas and Louisiana slope has been explained partly by the effects of the semi-permanent anticyclonic eddy and a partner cyclonic eddy. West of Cameron, Louisiana (93° W longitude), current measurements clearly show a strong response of coastal current to the winds, setting up a large-scale anticyclonic gyre. The inshore limb of the gyre is the westward or southwestward (downcoast) component that prevails along much of the coast, except in July-August. Because the coast is concave, the shoreward prevailing wind results in a convergence of coastal currents. A prevailing countercurrent toward the northeast along the shelf edge constitutes the outer limb of the gyre. The convergence at the southwestern end of the gyre migrates seasonally with the direction of the prevailing wind, ranging from a point south of the Rio Grande in the fall to the Cameron area by July. The gyre is normally absent in July but reappears in August/September when a downcoast wind component develops.

The Mississippi/Alabama shelf circulation pattern is not well understood at present. There appears to be divergent flow near the delta region. Offshore Panama City, Florida, the prevailing flow is eastward, but reversals occur at the time of maximum westward wind components. Offshore Mobile, Alabama, currents are eastward on the average, and flow reversals coincide with eastward winds. Most current reversals occur during summer or during Loop intrusion events. The inner shelf general circulation is a two-season event. During winter the water column is homogeneous and surface circulation is mainly alongshore and westward. The cross-shelf component is weaker and directed onshore. During spring-summer conditions, the surface flow is mostly eastward. Under winds with easterly components, the water tends to flow shoreward and accumulate against the shoreline creating a pressure gradient that drives bottom water alongshore in the direction of the winds. However, Loop Current intrusions, when present, will completely dominate the shelf circulation.

The west Florida shelf circulation is dominated by tides, winds, eddy-like perturbations, and the Loop Current. The flow consists of three regimes: the outer shelf, the mid-shelf, and the coastal boundary layer. Also, the Loop current and eddy-like perturbations are stronger in this region. During Loop intrusion events, upwelling of colder, nutrient-rich waters has been observed. In waters less than 30m (98 ft) the wind-driven flow is mostly alongshore and parallel to the isobaths. A weak mean flow is directed southward in the surface layer. In the coastal boundary layer, longshore currents driven by winds, tides, and density gradients predominate over the cross-shelf component (Science Application International Corporation (SAIC), 1986). Common flow ranges from moderate to strong, and the tidal components are moderate. Longshore currents due to winter northerlies, tropical storms, and hurricanes may range much higher, depending on local topography, fetch, and duration. Longshore currents, consisting of tidal, wind-driven, and density-gradient components, predominate over across-shelf components within a narrow band (10-20 km) close to the coast, referred to as the coastal boundary layer.

Sea-surface temperatures in the Gulf range from nearly constant throughout (isothermal) (29-30° C) in August to a sharp horizontal gradient in January, (from 25° C in the Loop core to 14-15° C along the northern shelves). Surface salinities along the northern Gulf are seasonal. During months of low freshwater input, salinities near the coastline range between 29-32 ppt. High freshwater inputs (spring-summer months) are characterized by strong horizontal salinity gradients and inner shelf values of less than 20 ppt (Wallace, 1980; Cochrane and Kelly, 1986). The vertical distribution of temperature reveals that in January, the thermocline depth is about 30 to 61m (98-200 ft) in the northeastern Gulf and 91 to 107m (298-350 ft) in the northwestern Gulf. In May, the thermocline depth is about 46 m (150 ft) throughout the entire Gulf (Robinson, 1973).

Dissolved oxygen varies seasonally, with a slight lowering during the summer months.

Very low oxygen levels (hypoxia) have been found to occur in some areas of open Gulf bottom waters. A zone of hypoxia affecting up to 16,500 square kilometers of bottom waters during mid-summer on the inner continental shelf from the Mississippi River delta to the upper Texas coast has been identified, most likely the result of high summer temperatures combined with freshwater runoff carrying large nutrient loads from the Mississippi River.

Estuaries are found from east Texas through Louisiana, Mississippi, Alabama, and northwestern Florida. Estuaries of the Gulf of Mexico export considerable quantities of organic material, thereby enriching the adjacent continental shelf areas.

4.2.3. U.S. Caribbean

The waters of the Caribbean region include the coastal waters surrounding the U.S. Virgin Islands and Puerto Rico. The marine habitats found within the region are both the products of and key factors shaping local terrestrial, geological, and hydrological regimes. The territory of the U.S. Virgin Islands includes roughly 63 islands in total, the largest of which are St. Thomas (83 square kilometers or 32 square miles), St. John (52 square kilometers or 20 square miles), and St. Croix (207 square kilometers or 80 square miles). The commonwealth of Puerto Rico includes many islands, the largest of which is Puerto Rico. To the south lie numerous cays covered with sand, coral, and mangroves. To the west lie Mona, Monito, and Desecheo Islands. To the northeast lies the chain of islands called La Cordillera. To the southeast lies Vieques Island. All of these Caribbean islands, with the exception of St. Croix, are part of a volcanic chain of islands formed by the subduction of one tectonic plate beneath another. There, tremendously diverse habitats and the consistent light and temperature regimes characteristic of the tropics are conducive to high species diversity.

4.2.3.1 Insular Shelf Features.

Puerto Rico and the US Virgin Islands contain a wide variety of coastal marine habitats, including coral and rock reefs, seagrass beds, mangrove lagoons, sand and algal plains, soft bottom areas, and sandy beaches. These habitats are, however, very patchily distributed. Near shore waters range from 0 to 20 meters in depth and outer shelf waters range from 20 to 30 meters in depth at the shelf break. Along the north coast of Puerto Rico, the insular shelf is very narrow (2-3 km wide), seas are generally rough, and few good harbors are present. The coast is a mixture of coral and rock reefs, and sandy beaches. The east coast has an extensive shelf that extends to the British Virgin Islands. Much of the bottom is sandy, commonly with algal and sponge communities within depth ranges from 18 to 30 m. The southeast coast has a narrow shelf (8 km wide). About 25 km to the southeast is Grappler Bank, a small seamount whose peak is at 70 m depth below the sea surface. The central south coast broadens slightly to 15 km and an extensive seagrass bed extends 9 km offshore to Caja de Muertos Island. Further westward, the shelf narrows again to just 2 km before widening at the southwest corner to over 10 km. The whole of the southern shelf is characterized by hard or sand-algal bottoms with emergent coral reefs, grassbeds, and shelf edge. Along the southern portion of the west coast the expanse of shelf continues to widen reaching 25 km at its maximum. A broad expanse of the shelf is found between 14 and 27 m; habitats are similar to those of the south coast. To the north, along the west coast, the shelf rapidly narrows to 2-3 km.

4.2.3.2 Physical Oceanography (Water Movements and Marine Habitats)

Hydrologic patterns link the waters of the U.S. Caribbean with the Florida Keys and southeastern Florida. The marine waters of the U.S. Caribbean are primarily influenced by the waters of the westward flowing North Equatorial Current. The North Equatorial Current is the predominant hydrological driving force in the Caribbean region. It flows from east to west along the northern boundary of the Caribbean plateau and splits at the Lesser Antilles. The North Equatorial Current flows westward along the north coasts of the islands. North of the Mona Channel it splits, with one branch flowing north of Silver and Navidad Banks, past Turks and Caicos to form the Bahamas Current. The southern branch stays along the north coast of Hispañola about 30 km offshore. A small gyre has been documented off the northwest corner of Puerto Rico resulting in an east flow nearshore in this area.

The north branch of the Caribbean Current flows west into the Caribbean Basin. It is located about 100 km south of the islands, but its position varies seasonally. During the winter it is found further to the south than in summer. Flow along the south coast of Puerto Rico is generally westerly, but this is offset by gyres formed between the Caribbean Current and the island. The Antilles Current flows to the west along the northern edge of the Bahamas Bank and so links the waters of the Caribbean to those of southeastern Florida. Several rivers exert intermittent but important influence on the waters of the Caribbean Basin including the Amazon, the Orinoco, the Magdelana, and the Columbian. The plume from the Orinoco River flows up the Lesser Antilles and along the Greater Antilles and can carry with it high concentrations of suspended particles, unique chemical properties, and biota near to the south coast of Puerto Rico. The plume, therefore, can be responsible for events of high turbidity and algal blooms that usually occur in the Caribbean Basin in October.

Coastal surface water temperatures remain fairly constant throughout the year and average between 26° and 30° C. Salinity of coastal waters is purely oceanic (around 36 ppt); but in enclosed or semi-enclosed embayments, salinity may vary widely depending on fluvial and evaporational influences.

It is believed that no up-welling occurs in the waters of the U.S. Caribbean (except perhaps during storm events) and, since the waters are relatively stratified, they are severely nutrient-limited. In tropical waters nitrogen is the principal limiting nutrient.

4.2.3.3 Coastal Habitats

Billfishes are known to move close to shore off Puerto Rico and the Virgin Islands although this is probably because of the narrow width of the insular shelf. These waters are relatively nutrient poor and so have low rates of primary and secondary productivity, but these waters display some of the greatest diversity of any part of the south Atlantic region. High and diverse concentrations of biota are found where habitat is abundant. Coral reefs, seagrass beds, and mangrove ecosystems are the most productive of the habitat types found in the Caribbean, but other areas such as soft-bottom lagoons, algal hard grounds, mud flats, salt ponds, sandy beaches, and rocky shores are also important in overall productivity. These diverse habitats allow for diverse floral and faunal populations.

4.3. Life History Descriptions and Essential Fish Habitat

4.3.1. Introduction

For highly mobile, pelagic species such as billfishes, defining essential fish habitat (EFH) offers unique challenges. Collectively, these species are widely dispersed in oceanic, neritic (waters over the continental shelf), and coastal waters and move frequently over great horizontal distances and commonly migrate vertically within the water column. In the following accounts, these movements will only be referred to as migrations for those species for which there is evidence of seasonality or regularity.

The NMFS EFH regulations require that NMFS and the regional fishery management councils use the best available scientific information to determine EFH for all managed species. According to the EFH regulations, an initial inventory of available environmental and fisheries data sources should be undertaken to compile information necessary to describe and identify EFH and to identify major species-specific habitat data gaps. Available information should be evaluated through hierarchical analysis based on (1) presence/absence of the species in specific habitats; (2) habitat-related densities or relative abundances; (3) growth, reproduction, or survival rate comparisons between habitats; and (4) habitat-dependent production rates (quantified by habitat quantities, qualities and specific locations). The information gathered should be interpreted with a risk-averse approach to ensure that adequate areas are protected as EFH for the managed species.

In order to fulfill the requirements of the EFH regulations and the Magnuson-Stevens Act, NMFS scientists (SEFSC) conducted a complete review of the most recent information available. Their review covered the life histories of all billfish species with emphasis on the factors that influence distribution of the species. Much of the descriptive information is from the 1970-1980s, although each year the Standing Committee on Research and Science (SCRS) of ICCAT reviews and updates available information on species biology and stock structure. NMFS scientists made full use of the latest annual reports to ensure that the habitat information utilized was up-to-date. This published information was augmented with fishery-independent data sources (directed research investigations) and fishery-dependent sources. For billfishes, much of the available information comes from fishery-dependent sources (capture, catch (and/or tag) and release fishing, and bycatch reporting); although the capture location information is suitable for Geographic Information System (GIS)-based spatial analysis of distributions, there is a general lack of accompanying environmental or habitat data with which to define tolerances or preferences. (Data sources are detailed in EFH Appendix 1.) All life history, distributional and habitat use information was submitted to a group of independent reviewers who submitted separate reviews of the draft manuscripts. Their comments were considered and assessed by the scientific author and included as appropriate. We are grateful to these reviewers for their excellent contribution to this chapter, ensuring that the information is complete and up-to-date.

Identifying EFH for billfishes is particularly unique because they are primarily blue-water (i.e., open-ocean) species, although some species or life stages may frequent the neritic waters of the continental shelf. Their distributions are usually not correlated with the areas or features one commonly thinks of as fish habitat (e.g., seagrass beds or estuarine subtidal rock bottoms) and for which one can describe parameters such as bottom sediment type or vegetative density. Billfishes most often associate with physiographic structure in the water column (features including oceanic fronts, river plumes, current boundaries, shelf edges, sea mounts, and temperature discontinuities, and the interactions of these); it is these features that must be characterized as habitat for these species. Distribution of juveniles, adults, and especially larvae, may be constrained by tolerance of temperature, salinity or oxygen levels. These physicochemical properties may be used to define the boundaries of billfish habitat in a broad sense. However, even when these parameters and tolerances are well understood and can be used to define the limits of a habitat, the distribution of these characteristics is not fixed in space or time, varying over seasons and years.

The EFH regulations also require the identification of actions that might potentially impact EFH and conservation measures to mitigate these potential threats. Many of the threats occur in inshore or estuarine areas but have the potential to impact offshore habitats because of current patterns in the nearshore and on the continental shelf. The wide distribution of the billfishes and their EFH requires that a broad approach to habitat protection be taken. White marlin and sailfish use estuarine and coastal waters, particularly for spawning (sailfish). Loss or degradation of these coastal habitats may result in concomitant declines in productivity.

Habitat protection is equally important for the pelagic life stages of the billfish. In spite of the apparent distance of their prime habitats from shore, they are susceptible to adverse effects from inshore activities because their distributions are correlated with river plumes, current boundaries, canyons and convergence zones which can serve to transport or concentrate materials directly into offshore habitats. Threats to EFH from both fishing and non-fishing activities are treated in detail under section 4.4.

Process for Identification of EFH for Billfishes

There is evidence that certain areas serve important habitat functions, either throughout the year or seasonally, such as spawning grounds. Although actual spawning has not been observed for many of these species, the presence of eggs and larvae is frequently used as a proxy for spawning areas. Therefore, the location of spawning grounds has only been defined in a very broad sense. It is not known what parameters, beyond some temperature boundaries, define these as appropriate spawning areas. Additionally, eggs and larvae of these species are some of the rarest collected, and the picture of spawning and distribution of eggs and larvae is far from complete. Larvae and juveniles have a rapid growth rate, and few specimens, especially of early juveniles, are ever collected. When larvae have been collected, their identification to species has proven to be very difficult and it is likely that many earlier identifications have been incorrect (W.J. Richards, per. comm.). In some cases even the identification of adults is problematic and therefore caution was used when interpreting data. It is clear that much more research is needed on spawning grounds, species identifications, and habitat requirements before areas of importance to billfish can be more clearly refined.

Under the Magnuson-Stevens Act, EFH includes areas necessary for feeding. Billfishes may exhibit different feeding characteristics in different parts of their ranges. While researchers have identified relative proportions of prey in their diets, it appears that they are opportunistic feeders able to exploit a large diversity of fishes, cephalopods and crustaceans. This precludes the use of any major preys' distributions as indicators of billfish EFH. Additional research into prey dynamics is necessary to gain a better understanding of the importance of prey species to the tunas and swordfish. It has been suggested that the billfish associate with water column structure because it offers prime feeding opportunities; these structural habitats tend to coincide with areas of upwelling, convergence zones, and other hydrographic features. Much of the information on the distribution of billfishes suggests that the utilization of these feeding areas has a temporal or seasonal component that should be more fully explored and delineated in future research.

There are few additional guidelines that help refine EFH for these species. Some species appear to be primarily distributed above the thermocline or between certain isotherms; these temperature limits may define the outer boundaries of EFH for those species. As mentioned above, some species aggregate at frontal boundaries in the ocean, with floating objects (such as *Sargassum*), or at bottom features such as the continental shelf break, submarine canyons, and even shipwrecks. Occasionally, the aggregations form where a front or boundary lies above one of these bottom features. These aggregations are most likely associated with prime feeding grounds and as such are identified as EFH.

Based on the available data or scientific knowledge, EFH for Atlantic billfish has been identified for each species. Life history stages have been combined into logical ecological groupings indicative of habitat use:

- "**Spawning, eggs and larvae**" largely depend on spawning locations and water motion to control their distributions. Spawning locations are identified based on published accounts that identify concentrations of spawning activity or extrapolate probable locations upcurrent of egg and larval distributions.
- "**Juveniles and subadults**" are swimming stages that show increased mobility patterns and develop transient lifestyles. Some fish in this size class are taken by targeted fishing and as bycatch.
- "**Adults**" are fish that are sexually mature; the size criterion is "those fish greater than or equal to the size at first maturation of females." For billfishes they are the bulk of the fishery because of the minimum size limit regulations.

The current EFH descriptions and delineations for billfishes conform to the standards proposed by the NMFS regulations. Since the current status of the scientific knowledge of these species is such that habitat preferences are largely undefined or are difficult to determine, EFH is based on presence/absence and relative abundance data, as available. To the extent that environmental information is available, it has been included in the EFH descriptions. The most common factors included are temperature and salinity ranges, depths (isobaths), and association with particular water masses or currents. The textual accounts for each species serve as the legal description of EFH and where environmental characterizations are known, they have been included. Maps are provided as supplemental material to facilitate visualization of EFH locations. On the maps, shaded polygons have been drawn, based on analysis of the available data, marking the outer boundaries of EFH for each life stage. Locations, within the boundaries of EFH for a species' life stage, that do not meet the added environmental factors provided (e.g., salinity or temperature) are not considered EFH.

The following life history accounts details what is known about each species' life history, distribution and ecological roles as they relate to habitat use. Current status of the fishery is included since it may have implications in the current or historic range of the species. In general, the designations of EFH for billfishes, as they currently stand, are a combination of life history information, expert opinion regarding the importance of certain areas, and presence/absence and relative abundance information from fishery independent and dependent sources. As mentioned earlier, much of the work on the basic ecology of these fishes is not recent; most is from the 1980's or before. More basic research on life history, habitat use, behavior and distribution of different life stages, is needed to further refine the description of EFH for these species.

4.3.2. Species Accounts and Essential Fish Habitat

Blue Marlin *(Makaira nigricans)*

Distribution: Blue marlin inhabit the tropical and subtropical waters of the Atlantic, Pacific and Indian Oceans. Their geographic range is from 45°N to 35°S latitude. In the Atlantic, two seasonal concentrations occur: January to April in the southwest Atlantic from 5° to 30°S, and from June to October in the northwest Atlantic between 10°and 35°N. May, November and December are transitional months (Rivas, L.R. *in* Shomura and Williams, 1975). This species is epipelagic and oceanic. It is generally found in blue water with a temperature range of 22- 31° C. In the northern Gulf of Mexico fishermen tend to catch more blue marlin when white marlin catches are lowest and vice versa; this probably reflects differences in habitat preferences rather than any sort of interaction between the species. Blue marlin are generally solitary, and do not occur in schools or in coastal waters (Nakamura, 1985). It has been believed that the North and South Atlantic contained two separate spawning populations, but recent evidence, including genetic data, suggests there is intermingling of the two groups. Consistent with SCRS recommendations, this amendment considers there to be a single stock of Atlantic blue marlin. Tag-recapture data from the northern Gulf of Mexico and the Bahamas suggest seasonal movements between the Gulf of Mexico (summer) and the Bahamas (winter), and two-way movements between the Caribbean Islands and Venezuela and the Bahamas, and at least one-way movements from St. Thomas to west Africa. Blue marlin from this study traveled up to 7,000 km (4350 mi) and have remained at-large (i.e., from tagging until recapture) for up to eight years (Witzell and Scott, 1990).

A total of 21,547 blue marlin have been tagged and released over the last 43 years as part of the Cooperative Tagging Center (CTC) program, with the recapture of 147 tagged fish reported (0.68 percent of all releases) over the 23 year collaborative tagging effort (Jones *et al.*, 1997). Most tagging activity has taken place off the U.S. east coast, Gulf of Mexico and Caribbean Sea, generally during the months of July through September. The majority of blue marlin were recaptured in the general area of their release, traveling an average distance of 488 nm. Strong seasonal patterns of movement of individuals between the U.S. and Venezuela are also evident (SCRS, 1997). Some individuals have exhibited extended movement patterns. A blue marlin released off Delaware and recovered off the island of Mauritius in the Indian Ocean, represents the only documented inter-ocean movement of a highly migratory species in the history of CTC. The minimum straight line distance traveled for this fish was 9,100 nm in 1,108 days-at-large (roughly three years). Other extensive movements include trans-equatorial movements, and trans-Atlantic migrations (5.4 percent of CTC recaptures; Jones *et al.*, 1997).

Predator-prey relationships: Blue marlin feed near the surface but also are known to feed more deeply than the other istiophorids; stomach contents have included deepsea fishes, such as chiasmodontids. Blue marlin feed primarily on tuna-like fishes and squid and on a wide size range of other organisms, from 38 mm postlarval surgeonfish to 50 lb. bigeye tuna. Important prey species vary by location and include dolphinfishes and tuna-like fishes, especially bullet tuna (*Auxis* sp.) around the Bahamas, Puerto Rico, and Jamaica, and dolphinfishes and scombrids in the Gulf of Mexico. Other prey items include squids and octopods (Nakamura, 1985; Davies and Bortone, 1976; Rivas, 1975). Predators of blue marlin are relatively unknown. Sharks will attack hooked billfish, but it is not known if they attack free-swimming healthy individuals.

Reproduction and Early Life History: Although recent evidence indicates mixing between the two geographic areas, there are probably two separate spawning “events” (or populations), one in the north Atlantic with spawning from July to September (July to October according to de Sylva and Breder, 1997; May to November, according to Prince *et al.*, 1991) and one in the south Atlantic from February to March. May and June are the peak spawning months for fish off Florida and the Bahamas. There is a protracted spawning period off northwest Puerto Rico from May to November. Females taken off Cape Hatteras in June were found to have recently spawned (Rivas, 1975). Very few larvae have been collected in the western Atlantic, but some have been found off Georgia, in the Gulf of Mexico, off Cat Cay, Bahamas, and in the mid- north Atlantic (Nakamura, 1975; Ueyanagi *et al.*, 1970; W.J. Richards, pers. comm.). A few juveniles have been identified off Jamaica (Caldwell, 1962) and one from the Gulf of Mexico (W.J. Richards, pers. comm.).

Blue marlin are sexually mature by ages 2-4 (SCRS, 1997). Female blue marlin begin to mature at approximately 104-134 lbs, while males mature at smaller weights, generally from 77-97 lbs. Analysis of egg (ova) diameter frequency suggests that blue marlin, white marlin, and sailfish spawn more than once, and possibly up to four times a year (de Sylva, 1997). During the spawning season, blue marlin release from one million to ten million, small (1-2mm) transparent pelagic planktonic eggs (Yeo, 1978). Number of eggs has been correlated to interspecific sizes among billfish and size of individuals within the same species. Ovaries from a 324 lb female blue marlin from the northwest Atlantic were estimated to contain 10.9 million eggs, while ovaries of a 275 lb female were estimated to contain approximately 7 million eggs.

Fisheries: Blue marlin are targeted as a recreational fishery in the U.S. and Caribbean, and are also caught as bycatch of tropical tuna longline fisheries which use shallow gear deployment. They are also caught by longline offshore fisheries which target swordfish, especially in the western Atlantic, as well as by directed artisanal fisheries in the Caribbean. Further discussion of the Atlantic billfish fishery is provided in Section 4.7. **U.S. Fishery Status:** Overfished. The effect of reduced stock size on habitat use, migrations or distribution is unknown but should be investigated in future research.

Growth and mortality: Blue marlin are believed to be one of the fastest growing of all teleosts in the early stages of development, and weigh between 30 to 45 kg by age 1 (SCRS, 1997). Based on analysis of daily otolith ring counts, they reach 24 cm LJFL (lower jaw fork length) in about 40 days, and about 190 cm LJFL in 500 days, with a maximum growth rate of approximately 1.66 cm/day occurring at 39 cm LJFL (Prince *et al.*, 1991). Fish larger than 190 cm LJFL tend to add weight more than length, making application of traditional growth curve models, in which length or weight are predicted as a function of age, difficult for fish in these larger size categories. Females grow faster and reach much larger maximum sizes than males. Examination of sagitta (otolith) weight, body weight, and length/age characteristics indicate that sex-related size differences are related to differential growth between sexes and not to differential mortality (Wilson *et al.*, 1991). Sexually dimorphic growth variation (weight only) in blue marlin appears to begin at 140 cm LJFL (Prince *et al.*, 1991). Somatic growth of male blue marlin slows significantly at about 220 lbs, while females continue substantial growth throughout out their lifetime (Wilson *et al.*, 1991). Male blue marlin usually do not exceed 350 lbs, while females can exceed 1,200 lbs.

Blue marlin are estimated to reach ages of at least 20-30 years, based on analysis of dorsal spines (Hill *et al.*, 1990). Although, this spine ageing technique has not been validated, longevity estimates are supported by tagging data. The maximum time at liberty recorded of a tagged individual was 4,024 days (about 11 years) for a blue marlin that was estimated to weigh 65 pounds at the time of release (SCRS, 1996b). Sagitta otolith weight is suggested to be proportional to age, indicating that both sexes are equally long-lived, based on the maximum otolith weight observed for each sex (Wilson *et al.*, 1991). Additionally, predicting age from length or weight is imprecise due to many age classes in the fishery (SCRS, 1996b). Estimates of natural mortality rates for billfish would be expected to be relatively low, generally in the range of 0.15 to 0.30, based on body size, behavior and physiology (SCRS, 1996b).

Habitat associations: Adults are confined to the tropics within the 24°C isotherm, and make seasonal movements related to changes in sea surface temperatures. In the northern Gulf of Mexico they are associated with the Loop Current, and are found in blue waters of low productivity rather than more productive greenwaters. Off Puerto Rico, the largest numbers of blue marlins are caught during August, September and October. Equal numbers of both sexes occur off northwest Puerto Rico in July and August, with larger males found there in May and smaller males in September (Rivas, 1975). Very large individuals, probably females, are found off the southern coast of Jamaica in the summer and off the northern coast in winter. In December and January males are caught here. All habitat information is summarized in Table 4.3 - 1.

Essential Fish Habitat (EFH) for Blue Marlin (Figure 4.3.2a-d):

- **Spawning, eggs and larvae:** Offshore of Florida, identical to adult EFH in that area: from offshore Ponce de Leon Inlet (29.5° N) south to offshore Melbourne, FL from the 100m to 50 mi seaward (79.25° W); from offshore Melbourne, FL south to Key West from 100 m isobath to the EEZ; Also, off the northwest coast of Puerto Rico (from Arecibo to Mayaguez), bounded by the 2000m isobath to the north and 18° N to the south.

- **Juveniles/Subadults (20-189 cm LJFL):** Pelagic surface waters not less than 24° C, offshore of Delaware Bay to Cape Lookout from the 100m isobath to the 2000m isobath, and grading further offshore to 73.25 °W at 35°N; continuing south from offshore of Cape Lookout to Cumberland Island, GA (30.75° N), from the 200m to 2000 m isobath; offshore St. Augustine (30° N) south to 26°N, (Ft Lauderdale, Fl) from the 100m isobath offshore an additional 30 miles to 29°N , then south of 29°N, seaward from the 100m isobath to the EEZ; off southwest Florida from 24.5 N between the 200m isobath and the EEZ, north to 28°N, west to 86.25°, and south to the EEZ; offshore Choctawhatchee Bay to Terrebonne Parish, LA, from the 100m isobath to the 2000m isobath , continuing west along the 200m isobath to the Texas/Mexico border out to 2000 meters

- **Adults (190 cm LJFL):** Pelagic surface waters not less than 24° C, from offshore Delaware Bay (38.5°N) south to offshore Wilmington, NC (33.5° N) between 100 and 2000 m; offshore Charleston, SC (32° N) from 100 m to 78°W to offshore the GA-FL border (30.75° N); from offshore Ponce de Leon Inlet (29.5° N) south to offshore Melbourne, FL from the 100m to 50 mi seaward (79.25° W); from offshore Melbourne, FL south to Key West from 100 m isobath to the EEZ; from offshore Choctawhatchee Bay (86°W) to offshore Terrebonne Parish, LA (90° W) between 100-2000 m; from Terrebonne Parish, LA south to offshore Galveston, TX (95° W) between 200-2000 m isobaths; Puerto Rico and US Virgin Islands: From 65.25° W east and south to the EEZ, northern boundary along the 100 m isobath. Also, off northern shore of Puerto Rico out to the 2000m isobath from 65.5° W, west to the EEZ, and along southern coast of Puerto Rico out to 2000m isobath, east to 66.5° W.

White Marlin *(Tetrapturus albidus)*

Distribution: White marlin is an oceanic epipelagic species that occurs only in the Atlantic Ocean. It inhabits almost the entire Atlantic Ocean from 45°N to 45°S latitude in the western Atlantic and 45°N to 35°S in the eastern Atlantic. In the tropics, white marlin usually occur above the thermocline in deep (depths greater than 100 m) blue water with surface temperatures above 22°C and salinities of 35 - 37 ppt. They are usually in the upper 20 -30 meters of the water column but may go to depths of 200 - 250 m where the thermocline is deep. In higher latitudes, such as between New Jersey and Virginia, they are found commonly in shallow coastal waters (de Sylva and Davis, 1963). White marlin are found at the higher latitudes of their range only in the warmer months. Although they are generally solitary, they sometimes are found in small, usually same-age groups. White marlin spawn in tropical and sub-tropical waters and move to higher latitudes during the summer (Nakamura, 1985; Mather *et al.*, 1975). Catches in some areas may include a rare species, *Tetrapturus georgei*, which is superficially similar to white marlin (W.J. Richards, pers. comm.). The so-called "hatchet marlin" (Pristas, 1980) may also represent *T. georgei*, and has been caught occasionally in the Gulf of Mexico (D. de Sylva, pers. comm.). The similarity between species means some reported catches have the potential for error.

This species undergoes extensive movements, although not as extreme as those of bluefin tuna and albacore. The longest distance traveled by a tagged and recaptured specimen, which had been at-large for 1.4 years, was 3,509 km. The longest time at-large recorded for a white marlin is 11.8 years. Transequatorial movements have not been documented for the species (Bayley and Prince, 1993). There have been 29,751 white marlin tagged and released by the CTC program, with 540 reported recaptures (1.8 percent of all releases). The majority of releases took place in the months of July through September, in the western Atlantic off the east coast of the United States. Releases of tagged white marlin also occurred off Venezuela, in the Gulf of Mexico, and in the central west Atlantic. As noted for blue marlin, the majority of recoveries occurred in the same general area as the original capture. The mean straight line distance of recaptured white marlin is 455 nm. A substantial number of individuals moved between the mid-Atlantic coast of the United States and the northeast coast of South America. Overall, 1.1 percent of documented white marlin recaptures have made trans-Atlantic movements. The longest movement was for a white marlin tagged during July, 1995, off the east coast near Cape May, NJ, and recaptured off Sierra Leone, West Africa, in November, 1996. The fish traveled a distance of at least 3,519 nm over 476 days (1.3 years; Jones et. al., 1997).

Predator–prey relationships: The most important prey items of adult white marlin, at least in the Gulf of Mexico, are squids, dolphinfishes (*Coryphaena*) and hardtail jack (*Caranx crysos*) , followed by mackerels, flyingfishes, and bonitos. Other food items found inconsistently and to a lesser degree include cutlassfishes, puffers, herrings, barracudas, moonfishes, triggerfishes, remoras, hammerhead sharks, and crabs. Along the central Atlantic coast, food items include round herring (*Etrumerus teres*) and the squid *(Loligo pealei*). Carangids and other fishes are consumed as well (Nakamura, 1985). Davies and Bortone (1976) found the most frequent stomach contents in 53 specimens from the northeastern Gulf of Mexico, off Florida and Mississippi, to include little tunny (*Euthynnus* sp.), bullet tuna (*Auxis* sp.), squid and moonfish (*Vomer setapinnis*). They also found white marlin to feed on barracuda and puffer fish. The only predators of adult white marlin may be sharks and possibly killer whales (Mather *et al.*, 1975).

Reproduction and Early Life History: Sexual maturity of female white marlin is reached at about 61 inches LJFL (44 lbs). Mature females probably spawn more than once a year and possibly up to four times during the spawning season. The spawning season probably occurs only once a year, from March to June (de Sylva and Breder, 1997). It is believed there are at least three spawning areas in the western north Atlantic: northeast of Little Bahama Bank off the Abaco Islands, northwest of Grand Bahama Island and southwest of Bermuda. Larvae have also been collected from November to April (Nakamura, 1985; Mather *et al.*, 1975), but these may have been sailfish (*Istiophorus platypterus*) larvae, as the two can not readily be distinguished (W.J. Richards, pers. comm.)

Fisheries: White marlin are targeted as a recreational fishery in the U.S. and Caribbean, and are also caught as bycatch of tropical tuna longline fisheries which use shallow gear deployment. They are also caught by offshore longline fisheries which target swordfish, especially in the western Atlantic, as well as by directed artisanal fisheries in the Caribbean. **U.S. Fishery Status:** Overfished. The effect of reduced stock size on habitat use, migrations or distribution is unknown but should be investigated in future research.

Growth and mortality: Adult white marlin grow to over 280 cm TL (total length) and 82 kg. White marlin exhibit sexually dimorphic growth patterns; females grow larger than males (Nakamura, 1985; Mather *et al.*, 1975), but the dimorphic growth differences are not as extreme as noted for blue marlin (SCRS, 1997). A minimum estimate of longevity can be calculated from the longest time at liberty for a tagged white marlin of 4,305 days (11.8 years). The individual was estimated to weigh 50 pounds at the time of first capture, resulting in a minimum age estimate of 14-15 years (SCRS, 1996b).

Habitat associations: The world's largest sport fishery for the species occurs in the summer from Cape Hatteras to Cape Cod, especially between Oregon Inlet, North Carolina and Atlantic City, New Jersey. Successful fishing occurs up to 80 miles offshore at submarine canyons, extending from Norfolk Canyon in the mid-Atlantic to Block Canyon off eastern Long Island (Mather, *et al.*, 1975). Concentrations are associated with rip currents and weed lines (fronts), and with bottom features such as steep dropoffs, submarine canyons and shoals (Nakamura, 1985). The spring peak season for white marlin sport fishing occurs in the Straits of Florida, southeast Florida, the Bahamas, off the north coasts of Puerto Rico and the Virgin Islands. In the Gulf of Mexico, summer concentrations are found off the Mississippi Delta and De Soto Canyon and at the edge of the continental shelf off Port Aransas, Texas, with a peak off the Delta in July, and in the vicinity of De Soto Canyon in August. In the Gulf of Mexico, adults appear to be associated with blue water of low productivity, being found with less frequency in more productive green water (shelf waters). While this is also true of the blue marlin, there appears to be a contrast in the factors controlling blue and white marlin abundances, as higher numbers of blue marlin are caught when catches of white marlin are low and vice versa (Nakamura, 1985; Rivas, 1975). It is believed that white marlin prefer slightly cooler temperatures than blue marlin (de Sylva, pers. comm.). Spawning occurs in early summer, in subtropical, deep oceanic waters with high surface temperatures and salinities (20 -29°C and over 35 ppt). Spawning concentrations occur off the Bahamas, Cuba, and the Greater Antilles;

probably beyond the U.S. EEZ although the locations are unconfirmed. Concentrations of white marlin in the northern Gulf of Mexico and from Cape Hatteras to Cape Cod are probably related to feeding rather than spawning (Mather *et al.*, 1975). All habitat information is summarized in Table 4.3 - 2.

Essential Fish Habitat (EFH) for White Marlin (Figure 4.3.3a-c):

• **Spawning, eggs and larvae:** At this time the available information is insufficient to identify EFH for this life stage.

• **Juvenile/Subadult (20-158 cm LJFL):** Pelagic waters warmer than 22° C, from offshore of the US east coast from the 50m isobath to the 2000m isobath from the EEZ at Georges Bank at 41°N, south to offshore of Miami, FL at 25.25 °N; off the west coast of Florida, between the 200m and 2000m isobaths from 24.75°N to 27.75°N; then continuing between the 200m and 2000m isobaths west from 86°W to 93.5°W, then off the coast of Texas from west of 95.5°W to the 50m isobath and south to the EEZ.

• **Adults (159 cm LJFL):** Pelagic waters warmer than 22° C, from offshore of the northeast US coast from the 50m isobath to the 2000 m isobath from 33.75 ° N to 39.25° N, then extending along 39.25° N out to the EEZ; off the coast of South Carolina in the Charleston Bump area, in the region starting from the 200m isobath at 32.25°N, east to 78.25°W, south to 31°N, west to 79.5 °W and north to the 200 m isobath; offshore of Cape Canaveral, FL from the 200 m isobath, east at 29° N to the EEZ, south along the 200 m isobath and out to the EEZ to 82°W, in the vicinity of Key West, FL; in the Gulf of Mexico, from 86.5° W to the EEZ, along the 50 m isobath near De Soto canyon, then along the 100m isobath west to the EEZ offshore of the US/Mexico border.

<u>Sailfish (*Istiophorus platypterus*)</u>

Distribution: Sailfish have a circumtropical distribution (Post, 1998). They range from 40°N to 40°S latitude in the western Atlantic and 50°N to 32°S latitude in the eastern Atlantic. Sailfish are epipelagic and coastal to oceanic, and are usually found above the thermocline at a temperature range of 21° to 28°C, but may dive into deeper, colder water. These are the least oceanic of the Atlantic billfishes, often moving to inshore waters. They are found over the shelf edge, and are associated with land masses (E. Houde, pers. comm.). However, they have been found to travel farther offshore than was previously thought.

A total of 62,740 sailfish have been tagged and released through the efforts of the CTC program, with reported recapture of 1,090 sailfish (1.7 percent of all releases). Most releases occurred off southeast Florida, from north Florida to the Carolinas, the Gulf of Mexico, Venezuela, Mexico, the northern Bahamas and the U.S. Virgin Islands. One tagged and recaptured specimen traveled from Juno, Florida to the mid-Atlantic, a distance of 2,972 km (Bayley and Prince, 1993). The longest movement tracked by tagging was 3,509 km, with this specimen at-large for 1.4 yrs. The longest period a recaptured tagged animal was found to be at-large was 10.9 years (Bayley and Prince, 1993). During the winter, sailfish are restricted to the warmer parts of their range, and move farther from the tropics during the summer (Nakamura, 1985; Beardsley *et al.*, 1975). The summer distribution of sailfish does not extend as far north as for the marlins. Tag-and-recapture efforts have recovered specimens only as far north as Cape Hatteras. Few transatlantic or transequatorial movements have been documented using tag-recapture methods (Bayley and Prince, 1993).

Predator-prey relationships: Early larvae feed on copepods, but shift to eating fish when they reach 6.0 mm in size. The diet of adult sailfish caught around Florida consists mainly of pelagic fishes such as little thunny (*Euthynnus alletteratus*), halfbeaks (*Hemiramphus* spp.), cutlassfish (*Trichiurus lepturus*), rudderfish (*Strongylura notatus*), jacks (*Caranx ruber*), pinfish (*Lagodon rhomboides*), and squids, including *Argonauta argo* and *Ommastrephes bartrami* (Nakamura, 1985). Sailfish are opportunistic feeders and there is unexpected evidence that they may feed on demersal species such as sea robin (Triglidae), cephalopods and gastropods found in deep water. Sailfish in the western Gulf of Mexico have been found to contain a large proportion of shrimp in their stomachs (Nakamura, 1985; Beardsley *et al.*,1975). Davies and Bortone (1976) report that the stomach contents of 11 sailfish from the Gulf of Mexico most frequently contained little thunny, bullet tuna (*Auxis* sp.), squid and Atlantic moonfish (*Vomer setapinnis*). Adult sailfish are probably not preyed upon often but predators include killer whales (*Orcinus orca*), bottlenose dolphin (*Tursiops turncatus*), and sharks (Beardsley et al., 1975).

Reproduction and Early Life History: Spawning has been reported to occur in shallow waters (30 - 40 ft) around Florida, from the Keys to the region off Palm Beach on the east coast. Spawning is also assumed, based on presence of larvae, offshore beyond the 100 m isobath from Cuba to the Carolinas, from April to September. However, the spawning has not been observed. Sexual maturity occurs in the third year, with females at a weight of 13 - 18 kg and males at 10 kg (de Sylva and Breder, 1997). Sailfish are multiple spawners, with spawning activity moving northward in the western Atlantic as the summer progresses. Larvae are found in Gulf Stream waters in the western Atlantic, and in offshore waters throughout the Gulf of Mexico from March to October (de Sylva and Breder, 1997; Nakamura, 1985; Beardsley *et al.*,1975).

Fisheries: Sailfish are primarily caught in directed sportfisheries and as bycatch of the commercial longline fisheries for tuna and swordfish. Historically, nearly all sailfish from commercial catches have been reported as Atlantic sailfish; however, nearly all of these represent longbill spearfish (and perhaps other spearfish) and it is probable that very few sailfish are taken commercially in the offshore waters of the Atlantic. Thus, it is impossible to determine historical trends in sailfish catches since at least two species have been combined.
U.S. Fishery Status: Overfished.

Growth and mortality: Most sailfish examined that have been caught off Florida are under three years of age. Mortality is estimated to be high in this area, as most of the population consists of only two year classes (Beardsley *et al.*, 1975). Sailfish are probably the slowest growing of the Atlantic istiophorids. Sexual dimorphic growth is found in sailfish, but it is not as extreme as with blue marlin (SCRS, 1997). An individual sailfish that was recaptured after 5,862 days (16 years) at liberty can be used to estimate minimum age of longevity. Unfortunately, the size at release is not available for this fish (SCRS, 1996b). The maximum age can be 13 to15 or more years. Growth rate in older individuals is very slow - 0.59 kg/yr (Prince *et al.*, 1985).

Habitat associations: In the winter, sailfish are found in schools around the Florida Keys and eastern Florida, in the Caribbean, and in offshore waters throughout the Gulf of Mexico. In the summer, they appear to diffuse northward along the U.S. coast as far north as the coast of Maine, although there is a population off the east coast of Florida all year long. During the summer, some of these fish move north along the inside edge of the Gulf Stream. After the arrival of northerlies in the winter they regroup off the east coast of Florida. Sailfish appear to spend most of their time above the thermocline, which occurs at depths of 10 - 20 m to 200 - 250 m, depending on location. The 28°C isotherm appears to be the optimal temperature for this species. Sailfish are mainly oceanic but migrate into shallow coastal waters. Larvae are associated with the warm waters of the Gulf Stream (Nakamura, 1985; Beardsley *et al.*, 1975; Post, 1998). All habitat information is summarized in Table 4.3 - 3.

Essential Fish Habitat (EFH) for Sailfish (Figure 4.3.4a-c):

• **Spawning, eggs and larvae:** From 28.25°N south to Key West, FL, associated with waters of the Gulf Stream and Florida Straits from 5 miles offshore out to the EEZ**.**

• **Juveniles/Subadults (20-142 cm LJFL):** In pelagic and coastal surface waters between 21° and 28° C, from 32° N south to Key West, FL in waters from 5 miles offshore to 125 miles offshore, or the EEZ whichever is nearer to shore; West of Key West, FL, all waters of the Gulf of Mexico from the 200m isobath to the 2000m isobath or the EEZ whichever is nearer to shore.

• **Adults (143 cm LJFL):** In pelagic and coastal surface waters between 21° and 28° C, offshore of the US southeast coast from 5miles off the coast to 2000 meters, from 36°N to 34°N, then from 5 miles offshore to 125 miles offshore, or the EEZ whichever is nearer to shore south to Key West, then from the 200m isobath to the 2000m isobath. Additional EFH is delineated in the Gulf of Mexico near the De Soto canyon up to the 50 m isobath, and areas 5 miles offshore of south east Texas, from Corpus Christy to the EEZ, or the 2000m isobath, whichever is closer.

Longbill Spearfish ***(Tetrapturus pfluegeri)***

Distribution: Only relatively recently (1963) has the longbill spearfish been reported as a new (distinct) species. It is known, but rare, from off the east coast of Florida, the Bahamas and the Gulf of Mexico, and from Georges Bank to Puerto Rico. More recently, it has been observed to be more widely distributed, mostly in the western Atlantic. The range for this species is from 40°N to 35°S latitude. It is an epipelagic, oceanic species, usually inhabiting waters above the thermocline (Nakamura, 1985; Robins, 1985). The species is generally found in offshore waters.

Predator-prey relationships: The diet of the longbill spearfish consists of pelagic fishes and squids. However, little data for diet specific to fish in the north Atlantic is available.

Life history: Spawning is thought to occur in widespread areas in the tropical and subtropical Atlantic (Nakamura, 1985) in the winter from November to May (de Sylva and Breder, 1997). There are a few records of larvae caught near the Mid-Atlantic Ridge from December to February, and in the Caribbean (de Sylva and Breder, 1997; Ueyanagi *et al.* , 1970; W.J. Richards, pers. comm.).

Fisheries: Longbill spearfish is not a target species, but is taken in the recreational fishery; the sportfishery catches only about 100 individuals per year. It is, however, taken as bycatch of the tuna longline fishery. **U.S. Fishery Status:** Unknown.

Growth and mortality: The maximum weight of females at first maturity is approximately 45 kg (de Sylva and Breder, 1997).

Habitat associations: The species ranges farther offshore than sailfish. Nothing is known about its habitat associations. All habitat information is summarized in Table 4.3 - 4.

Essential Fish Habitat (EFH) for Longbill Spearfish (Figure 4.3.5a-c):

- **Spawning, eggs and larvae:** At this time available information is insufficient to describe and identify EFH for this life stage.

- **Juvenile/Subadult (~20-182 cm LJFL):** Offshore of North Carolina, from 36.5°N to 35° N, from the 200m isobath to the EEZ.

- **Adults (183 cm LJFL):** Charleston Bump, area of the South Atlantic Bight from 78° W to 79° W, and from 37° N to 31° N; and southwest of the USVI from 65° W east to the EEZ or the 2000m isobath, whichever is nearer to shore.

4.4 Threats to Essential Fish Habitat

This section identifies the principal fishing- and non-fishing-related threats to billfish EFH as identified and described in Section 4.3 of this amendment. It also provides examples and information concerning the relationship between those threats and EFH and describes conservation and enhancement measures that can lessen the adverse impact to EFH. Other information sources and examples likely exist, and many new studies are underway or in various stages of completion or publication. Accordingly, the following discussion is presented as a starting point in the identification of threats to EFH and is intended to meet the strict time limitations imposed by the Magnuson-Stevens Act. The habitat provisions of this amendment represent an initial step in identifying EFH and the threats to EFH and provides a framework for continuing to focus attention on this critical area of fishery management. It is intended to stimulate further discussions, research and analyses that can be used to update and improve future versions of this document.

From the broadest perspective, fish habitat is the geographic area where the species occurs at any time during its life. Habitat area can be described in terms of location; physical, chemical and biological characteristics; and time. Ecologically, habitat includes structure or substrate that focuses distribution (e.g., coral reefs, topographic highs, areas of upwelling, frontal boundaries, particular sediment types, or submerged aquatic vegetation) and other characteristics (e.g., turbidity zones, salinity, temperature or oxygen gradients) that are less distinct but are still crucial to the species' continued use of the habitat.

Species use habitat for spawning, breeding, migration, feeding and growth, and for shelter from predation to increase survival. Spatially, habitat use may shift over time due to changes in life history stage, abundance of the species, competition from other species, and environmental variability in time and space. Species distributions and habitat use can be altered by habitat change and degradation resulting from human activities and impacts, or other factors. The type of habitat available, its attributes, and its functions are important to species productivity, diversity and survival.

The role of habitat in supporting the productivity of organisms has been well documented in the ecological literature and the linkage between habitat availability and fishery productivity has been examined for several fishery species. Because habitat is an essential element for sustaining the production of a species and, therefore, fisheries based on those species, the goals of FMPs cannot be achieved if the managed species do not have sufficient quantities of suitable habitat available to each life stage of the animal.

The quantitative relationships between fishery production and habitat are very complex and no reliable models currently exist. Accordingly, the degree to which habitat alterations have affected fishery production to date is unknown. In one of the few studies that has been able to investigate habitat-fishery productivity dynamics, Turner and Boesch (1987) examined the relationship between the extent of wetland habitats in the Gulf of Mexico and the yield of fishery species dependent on coastal bays and estuaries. They found correlations between reduced fishery stock production following wetland losses and stock gains following increases in the areal extent of wetlands. While most of these types of studies examined shrimp or menhaden productivity, other fisheries show varying degrees of dependence on particular habitats and likely follow similar trends. Accordingly, a significant threat facing fishery production is the loss of habitat, whether by natural and/or anthropogenic causes.

Species of the Atlantic billfish fishery utilize diverse habitats that have been identified as essential to various life stages. Pelagic species, such as the blue marlin and white marlin can most often be associated with areas of convergence or oceanographic fronts such as those found over submarine canyons, the edge of the continental shelf or the boundary currents (edge) of the Gulf Stream. These water column habitats can be characterized by their physical, chemical and biological parameters even though for some there is no substrate or hard structure in the traditional sense, e.g., a coral reef. These characteristics can subsequently be altered or degraded by impacts arising within the habitats (e.g., fishing activities) or from outside of the habitat (e.g., non-fishing activities).

4.4.1 Fishing Activities That May Adversely Affect EFH

The Magnuson-Stevens Act requires that Councils identify adverse effects to EFH caused by fishing activities and further requires that Councils manage the fisheries under their jurisdictions so as to minimize such impacts, to the extent practicable. The EFH regulation explains that "adverse effects from fishing may include physical, chemical, or biological alterations of the substrate, and loss of, or injury to, benthic organisms, prey species and their habitat, and other components of the ecosystem." Further, the regulations require that FMPs contain an assessment of the potential adverse effects of all fishing gear and practices used in waters described as EFH. The assessment should consider the relative impacts of gears on all different types of EFH identified. Special consideration is to be given to analysis of impacts from gears that will affect habitat areas of particular concern (HAPC). Councils are advised to use the best scientific information available, as well as other appropriate information sources, as available. In considering the information gaps identified through the assessment, Councils should consider the establishment of research closure areas and other measures to evaluate the impact of any fishing activity that physically alters EFH.

The following section includes an assessment of fishing gears and practices that are used in the billfish fishery, accompanied by conservation recommendations to minimize the potential impacts. Following the assessment is a brief discussion of the scientific review of information relating to fishing impacts to habitat. Jennings and Kaiser (1998) and Auster and Langton (1998), in recent reviews of fishing impacts to habitat, characterize fishing impacts hierarchically: impacts to structural components of habitat, effects on community structure, and effects on ecosystem processes. In this section the impacts of the billfish fishing activities will be addressed in the same format, followed by some discussion on non-HMS fishery impacts to billfish EFH and the identification of research priorities to provide additional information that can be used to improve future amendments to the FMP EFH provisions. In general, the fishing methods that are used in these fisheries are relatively non-damaging compared to many of the fishing gears used in other Councils' jurisdictions.

The following gears have been identified for the HMS Billfish fishery:

Atlantic Highly Migratory Species

Atlantic Billfishes: (Recreational only):

Fishery	**Approved Gear Type**
A. Hook and line fishery	A. Rod and reel, handline.

Physical Impacts of Billfish and HMS Fishing Gears on EFH

Billfish, the target species from this HMS fishery management unit, are associated with structure in the water column, either convergence zones or boundary areas between different currents. Because of the magnitude of these structures that are the frequent habitat of billfish and the processes that cause them, there is little effect that can be detected from the fishing activities undertaken to pursue these animals. None of the gears specified for the billfish fishery contact the substrate underlying the waters in which these species are targeted. Fishery scientists have recently begun to express concern over the use of lead for weight in inshore and inland fisheries. In lakes or streams the concentration of elemental lead has increased to a level that causes concern over its continued use as fishing tackle. Considering the expanse over which billfishing occurs, this is probably not a threat to the continued health of billfish EFH, but it should be kept in mind for future consideration of research topics. Based on the available information, the impacts from billfish fishing gears can be assumed to be negligible on the EFH.

Since there is considerable overlap in areas fished between billfish and other HMS, the gears that are used in other HMS fisheries have the potential to adversely impact billfish EFH. Of the approved gears in those fisheries, bottom-set longlines, principally set for sharks, contact the bottom substrate. Gear could become hung or entangled on various elements of the substrate including rocks, boulders, hard- or live-bottoms, hard or soft corals. In instances where billfishes are attracted to the habitat due to hydrographic characteristics, i.e., up-welling, convergences, etc., the scale of impact is probably not of sufficient magnitude to affect the characteristics of the habitat. If, however, the fish are attracted because of prey resources, the prey may be dependent on habitat characteristics that could be altered at these scales. It is recommended that fishers take appropriate measures to identify bottom obstructions and avoid setting gear in areas where it may become entangled. If gear is lost, diligent efforts should be made to recover the lost gear to avoid further fouling of the underwater habitat through "ghost fishing."

Population and Ecosystem Impacts of Removing Target Species

There is currently a great deal of interest in the ecosystem level effects of the removal of apex predators from aquatic systems. Although billfish have not been the subject of this type of research, other highly migratory species and commercially important species can be cited as examples of the ecosystem effects that might be expected. Branstetter (1997) suggests that increased survival of young tiger, dusky and sandbar sharks may be due to the removal of large sharks that ordinarily prey upon these juveniles. There is some evidence that removal of large sharks in coastal waters of South Africa has resulted in a proliferation of small shark species (Buxton, pers. comm.). Overfishing of cod in the northwest Atlantic has led to apparent "species replacement" where dogfish (sharks) have proliferated and assumed the ecological role previously served by cod. At the present time, it is believed that it may be difficult if not impossible to reverse the trend and re-establish cod populations.

In the ecological literature, it has been reported that natural ecosystems display a dynamic equilibrium that will maintain stability, within natural variation, as long as ecological disturbance is neither too intense nor too frequent. Removal of one trophic level (e.g., apex predators) would be considered a disturbance to the system. At moderate levels of disturbance, populations and ecosystems are likely able to compensate and maintain their biological integrity. Continued high rates of removal of billfish adults and juveniles (top predators) might be classified as a frequent and intense disturbance with the capacity to induce changes in the biological characteristics of the habitat. Continued disturbance could result in unforeseen ecological changes, detrimental to the long-term productivity of the billfish species resulting from changes in the biological characteristics of EFH. Suggested time-area closures, reducing the bycatch or capture of juvenile billfish, should be embraced as a risk-averse method to avoid changes to the biological characteristics of the billfish EFH and to help ensure the biological integrity of the habitats. Research into cascading ecological effects from apex predator removal should be encouraged.

Impacts to HMS EFH from non-HMS Fishing Gears and Practices

Because of the use of inshore habitats, e.g., sailfish spawning in coastal habitats off southeastern Florida, there is the potential for impact to billfish EFH from fisheries that target species with habitats that coincide with that of billfish. These fisheries may be either state or federally managed. Trawl fisheries that scrape the substrate, disturb boulders and their associated epiphytes or epifauna, re-suspend sediments, flatten burrows and disrupt seagrass beds have the potential to alter the characteristics that are important for attracting billfish to these habitats and are potentially important to the survival of early live stages of many of the target species that use these habitats. The degree of impact and long term habitat modification depends on the severity and frequency of the impacts as well as the amount of recovery time between impacts (Auster and Langton, 1998). The degree to which particular parameters are altered by trawl gear (e.g., shrimp trawlers) is somewhat dependent on the configuration of the gear and the manner in which the gear is fished. These impacts are, as yet, unidentified and unquantified. There is a serious need to gain a better understanding of the characteristics of particular habitats that influence the abundance of billfish species (e.g., sailfish) within those coastal habitats. Additional efforts are required to study the EFH areas that are fished for non-HMS species and identify fishing gears that are impacting habitat; coordination efforts should be undertaken with the respective fishery management councils (Council) to identify potential common areas. Information on the frequency of disturbance and the changes induced in the habitat are of primary importance.

In addition to the alteration of physical characteristics of EFH, other fisheries may remove prey species that make up the necessary biological components of the EFH for billfish. As an example, development or expansion of a squid fishery off the Atlantic coast has the potential to degrade the quality of EFH for billfish and other HMS since many of these species utilize a high percentage of squid in their diets. Research into the dynamics of these interactions between fisheries should be investigated for future consideration. If there is evidence that another fishery is depleting the resources associated with the EFH of billfish, the issue of resource allocation will need to be addressed with the appropriate Council(s).

Additionally, other fisheries may remove habitat components that are important to the integrity of billfish EFH. Many of these impacts have been addressed in other fishery management plans (e.g., SAFMC and GMFMC) that focus on restricting the removal of attached species such as corals or kelp that provide essential structure to the habitat but there are other biological components that must be considered for pelagic species. Many of the life stages for the billfish species have been found to be associated, or to co-occur, with floating mats various species of the brown algae, *sargassum*. The mats are mobile, following current patterns, and are frequently found in convergence zones, windrows, or at current boundaries. These areas are EFH of the billfish. Whether the floating mats serve as shelter, act as a source of prey (because of the abundance of prey species associated with the mats), serve as a means of camouflage, or serve some other biological function is not entirely clear. It is a biological component that serves to focus the distribution of certain life stages of the billfishes and it should be maintained in its habitat. Under the Magnuson-Stevens Act definitions, harvesting of sargassum would qualify as a "fishing activity." As such, we have been urged by the Billfish Advisory Panel to make strong recommendations against the harvest of sargassum within the U.S. EEZ. In order for this to be recommendation to be enforceable, it must also include recommendations that no *sargassum* can be possessed or landed within the US since it would be impossible to verify if *sargassum* was harvested outside the EEZ and simply transported back into U.S. waters for landing.

EFH Recommendations

The EFH regulations require that Councils must act to prevent, mitigate, or minimize any adverse effects from fishing, to the extent practicable, if there is evidence that a fishing practice is having an identifiable adverse effect on EFH, based on the assessment of fishing gears on EFH. Toward this end, Councils (NMFS) should consider whether, and to what extent, the fishing activity is adversely impacting EFH, including the fishery; the nature and extent of the adverse effect on EFH; and whether the management measures are practicable, taking into consideration the long and short-term costs as well as benefits to the fishery and its EFH.

At this time, there is no evidence that physical effects caused by fishing under this FMP are adversely affecting billfish EFH to the extent that detrimental effects can be identified on the habitat or the fisheries. The recommendations, listed above, should help to mitigate any impacts that are currently occurring but unverified. Additional study will be recommended to more adequately identify unrealized adverse impacts and to quantify impacts currently happening.

This fishery management plan amendment proposes the use of time-area closures to reduce the take of juvenile billfish. This should also be considered as a conservation measure that will help to maintain the biological integrity of the billfish EFH and reduce the chance of altering the biological characteristics of the billfish EFH. By preserving more of the age structure in the population and a diversity of trophic levels, the measure should lend added stability to the ecosystem upon which the billfish fishery depends. From an EFH perspective the alternative of time-area closures would be seen as a desirable step toward conserving and enhancing billfish EFH.

Any inshore areas that are identified as billfish EFH could be considered for restriction of HMS or non-HMS fishing in order to study the effects of gear impacts on billfish EFH. Research in these areas should be strongly advocated.

Further evaluations of fishing impacts on habitat will be undertaken as more research is conducted and information becomes available. Information will be reviewed annually for inclusion in future revisions to this EFH amendment.

4.4.2 Non-fishing Threats to EFH

Section 600.815 (a)(5) of the EFH regulations requires that FMPs identify non-fishing related activities that may potentially affect essential fish habitat (EFH) of managed species, either quantitatively or qualitatively, or both. In addition, Section 600.815 (a)(7) of the regulations requires that FMPs recommend conservation measures describing options to avoid, minimize, or compensate for adverse effects identified. Since the jurisdiction and the EFH of this Secretarial FMP overlaps with the EFH identified by the respective Councils, the threats to EFH and conservation measures compiled for this document are a synthesis of those listed in the Councils' EFH amendments. The information in this section has been adapted, with permission, from EFH amendments prepared by the Mid-Atlantic (MAFMC, 1998), South Atlantic (SAFMC, 1998) and Gulf of Mexico (GMFMC, 1998) Councils. Original sources of information are cited in those documents.

Broad categories of activities that may adversely affect EFH include, but are not limited to, (1) actions that physically alter structural components or substrate, e.g., dredging, filling, excavations, water diversions, impoundments and other hydrologic modifications; (2) actions that result in changes in habitat quality, e.g., point source discharges, activities that contribute to non-point-source pollution and increased sedimentation, introduction of potentially hazardous materials, or activities that diminish, or disrupt the functions of EFH. If these actions are persistent or intense enough, they can result in major changes in habitat quantity, as well as quality, or can result in conversion of habitats, or complete abandonment of habitats by some species.

Estuaries, coastal and offshore waters are used by humans for a variety of purposes that often result in some degree of degradation of these and adjacent environments, posing threats, either directly or indirectly, to the associated biota. These effects, either alone or combined with (cumulative) effects from other activities within the ecosystem, may contribute to the decline of some species or biological components of the habitat. In many cases such effects may be demonstrated, but often they are difficult to quantify.

Pollutants can be introduced into the aquatic environment through a number of vehicles, including point source discharge, non-point source discharges and atmospheric deposition. Pollutants (heavy metals, oil and grease, excess nutrients, improperly treated human and animal wastes, pesticides, herbicides and other chemicals) have been historically discharged into aquatic environments by point sources and non-point sources. These types of contaminants have been demonstrated to alter the growth, visual acuity, swimming speed, equilibrium, feeding rate, response time to stimuli, predation rate, spawning seasons, migration routes and resistance to disease and parasites of finfish and crustacea. In addition to the introduction of contaminants that cause direct effects on animal physiology, point source discharges have also affected essential habitat characteristics such as water flow, temperature, pH, dissolved oxygen, salinity, and other parameters that affect habitat suitability for individuals, populations and communities. The direct and synergistic effects of multiple discharge components such as heavy metals and various chemical compounds are not well understood but are increasingly of concern in research efforts. More subtle effects of contaminants such as endocrine disruption in aquatic organisms and reduced ability to reproduce or compete for food are also being identified.

Non-point source runoff has, perhaps, a more significant impact on coastal water quality particularly in recent times since tighter controls on point source discharges have been instituted. Activities that tend to increase the input of contaminants to aquatic environments through non-point sources include coastal development, urban runoff, inappropriate agriculture and silviculture practices, marinas and recreational boating, and hydromodification. Related activities such as utilization of septic systems, improper disposal or treatment of wastes can contribute biological contaminants, as well. Many of these activities, improperly carried out, result in large quantities of pesticides, nutrients, and pathogens in coastal waters. Excess nutrients are one of the greatest sources of coastal water contamination. Nutrient overenrichment can lead to noxious algal blooms, fish kills, and oxygen depletion or hypoxic, events. Researchers have found reduced or stressed fisheries populations to be common in areas where hypoxia occurs.

Because billfishes are epipelagic or neritic, the water column is the habitat of primary concern, and water quality degradation is considered to be the main environmental impact that could pose potential threats to these species. Because of the lack of information on the specific habitat characteristics that are important to billfish, our approach to this requirement is a little broader than might initially seem warranted. Although billfish range primarily offshore, as described in Section 4.3, some billfishes are known to occupy coastal habitats, ranging close inshore off Puerto Rico, the Virgin Islands, the Florida Keys and the east coast of Florida (e.g., spawning area for sailfish in 30-40 ft depths); these nearshore habitats are affected by actions that occur in coastal habitats (both terrestrial and marine) and adjacent estuaries. Billfish also are documented to aggregate over submarine canyons that can serve as conduits for currents moving from inshore across the continental shelf and slope. These currents may contain contaminants from in-shore and shore-based activities. Until the precise zones of influence from various river and coastal discharges can be delineated, a precautionary view should be taken in order to protect the integrity of billfish EFH and the sustainability of the billfish fishery.

As required under the EFH regulations, the following discussion identifies activities with the potential to adversely affect billfish EFH. In many cases these activities are regulated under various statutory authorities and, as long as they are regulated within those guidelines, their potential to adversely affect EFH may be reduced, but not necessarily eliminated. Many of the standards that are used to monitor these activities have been designed to address threats to human health and not long term impacts to fish or fish habitats. Additionally, if the activity fails to meet or is operated outside their permitted standards, they may adversely affect EFH. The EFH regulations require NMFS and the Councils to identify actions with the <u>potential</u> (emphasis added) to adversely affect EFH, including its biological, chemical and physical characteristics. The EFH regulations also recommend the examination of cumulative impacts to EFH. It is possible that the impacts from many actions, operating within their regulatory bounds, may cause adverse impacts to EFH. If these areas are not highlighted, in documents such as this amendment, unrecognized adverse effects could cause declines in our Nation's fisheries. For that reason, we have listed a broad range of activities to ensure that the potential to adversely affect EFH has been addressed relative to billfish needs.

In addition to identifying activities with the potential to adversely affect EFH, the Magnuson-Stevens Act and the EFH regulations require the inclusion of measures to conserve and enhance EFH. Each activity discussed below is followed by conservation measures to avoid, minimize or mitigate adverse effects on EFH. These recommendations include examples of both general and specific conservation measures that have been recommended by NMFS when consulting on similar proposed activities. In some cases, the recommendations are based on site-specific activities, in others the recommendations represent broad policy type guidelines. It should be understood that during EFH consultation, each project will be evaluated on its merits and the particular threats to EFH will be assessed at that time. NMFS' role in EFH consultation is no different from consultations under other authorities; it is to address the threats of proposed actions to fishery resources, marine, estuarine and anadromous habitats, and EFH on behalf of their constituents and their natural resource base. The Federal action agency, with the statutory authority to regulate the proposed action, weighs the recommendations of all commenters and decides on the appropriate action, modifications or mitigation before proceeding with a project. The conservation measures included in this amendment are meant to be examples of agency recommendations that might be made regarding particular projects. They are intended to assist other Federal agencies and entities developing projects or undertaking activities that may adversely affect EFH, in the planning process when minimization of adverse impacts to EFH can most effectively be incorporated into project designs and goals.

4.4.2.1 Marine Sand and Minerals Mining

Mining for sand (e.g., for beach nourishment projects), gravel, and shell stock, in coastal waters can result in water column effects through changes in circulation patters, increased turbidity, and decreased oxygen concentrations at deeply excavated sites where flushing is minimal. Deep borrow pits created by mining may become seasonally or permanently anaerobic. Marine mining also elevates suspended materials at mining sites and turbidity plumes may persist several kilometers from these sites. Resuspended sediments may contain contaminants such as heavy metals, pesticides, herbicides, and other toxins. Deep ocean extraction of mineral nodules is a possibility for some non-renewable minerals now facing depletion on land. Such operations are proposed for the deep ocean proper, where nodules are imbedded on oceanic oozes. Resuspension of these oozes can affect water clarity over wide areas, and could also potentially affect pelagic eggs and larvae.

Conservation measures:

- Sand mining and beach nourishment should not be allowed in or adjacent to billfish EFH during seasons when billfishes are utilizing the area, particularly during spawning seasons.

- Gravel extraction operations should be managed to avoid or minimize impacts to bathymetric structure in nearshore areas.

- An integrated environmental assessment, management, and monitoring program should be a part of any gravel or sand extraction operation, and encouraged at federal, and state levels.

- Plan and design mining activities to avoid significant resource areas important to billfish EFH.

- Mitigation and restoration should be an integral part of the management of gravel and sand extraction policies.

4.4.2.2 Offshore Oil and Gas Operations

Offshore oil and gas operations pose a considerable level of potential threat to marine ecosystems. Exploration and recovery operations may cause substantial localized bottom disturbance. However, more pertinent to billfishes is the threat of contaminating operational wastes associated with offshore exploration and development; the major operational wastes being drilling muds and cuttings and formation waters. In addition, there are hydrocarbon products, well completion and work-over fluids, spill clean-up chemicals, deck drainage, sanitary and domestic wastes, ballast water, and the large volume of unrefined and refined products that must be moved within the marine and coastal zones. Potential major contaminants used in oil and gas operations may be highly saline; have low pH; contain suspended solids, heavy metals, crude oil compounds, organic acids; or may generate high biological and chemical oxygen demands. Also, accidental discharges of oil - crude, diesel and other hydrocarbon products - and chemicals can occur at any stage of exploration, development, or production, the great majority of these being associated with product transportation activities. Blowouts and associated oil spills can occur at any operational phase when improperly balanced well pressures result in sudden, uncontrolled releases of petroleum hydrocarbons. To remove fixed plartorms explosives are frequently used. All of these result in harmful effects on marine water quality as well as the marine biota in the vicinity. In the Gulf of Mexico, oil and gas operations are extending to deeper and deeper waters throughout which billfishes are known to range. Considerable documentation exists that highlights the benefits of offshore production platforms as artificial reefs that attract numerous species of fish including highly migratory pelagic species. It is likely that the attraction of species increases the potential for exposure to contaminants, if they are released into the aquatic habitat from the platform.

Conservation measures:

- A plan should be in place to avoid the release of hydrocarbons, hydrocarbon-containing substances, drilling muds, or any other potentially toxic substance into the aquatic environment. Storage of these materials should be in enclosed tanks whenever feasible or, if not, in lined mud pits or other approved sites. Equipment should be maintained to prevent leakage. Catchment basins for collecting and storing surface runoff should be included in the project design.

- Exploration/production activities and facilities should be designed and maintained in a manner that will maintain natural water flow regimes, avoid blocking surface drainage, and avoid erosion in adjacent coastal areas.

- An oil spill response plan should be developed and coordinated with federal and state resource agencies.

- Activities on the OCS should be conducted so that petroleum-based substances such as drilling mud, oil residues, produced waters, or other toxic substances are not released into the water or onto the sea floor: drill cuttings should be shunted through a conduit and discharged near the sea floor, or transported ashore or to less sensitive, NMFS-approved offshore locations; drilling and production structures, including pipelines, generally should not be located within one mile of the base of a live reef.

- Prior to pipeline construction, less damaging, alternative modes of oil and gas transportation should be explored.

- State natural resource agencies should be involved in the preliminary pipeline planning process to prevent violations of water quality and habitat protection laws and to minimize impact of pipeline construction and operation on aquatic resources.

- Pipeline alignments should be located along routes that minimize damage to marine and estuarine habitat. Buried pipelines should be examined periodically for maintenance of adequate earthen cover.

- All vessels transporting fuels and other hazardous materials should be required to carry equipment to contain and retrieve the spill. Dispersants shall not be used to clean up fuels and hazardous materials unless approved by the EPA/Coast Guard and fishery agencies.

- NPDES permit conditions such as those relating to dissolved oxygen, temperature, impingement and entrainment, under the Clean Water Act should be monitored and strictly enforced in billfish EFH.

- NPDES permits should be reviewed every five years for all energy production facilities.

4.4.2.3 Coastal Development

Coastal development activities include urban, suburban, commercial and industrial construction, along with development of corresponding infrastructure. These activities may result in erosion and sedimentation, dredging and filling (see following subsection), point and non-point source discharges of nutrients, chemicals, and cooling water into estuarine, coastal and ocean waters. Industrial point source discharges can result in the contamination of water and degradation of water quality by introducing organics and heavy metals or altering other characteristics such as pH and dissolved oxygen. Improperly treated sewage treatment effluent has been shown to produce changes in water quality as a result of chlorination and increased contaminant loading, including solids, phosphorus, nitrogen and other organics, and human pathogens and parasites. Non-point source pollution - that which results from land runoff, atmospheric deposition, drainage, groundwater seepage, or hydrologic modification - results in the deposition of pathogens, nutrients, sediments, heavy metals, oxygen demanding substances, road salts, hydrocarbons and other toxics. Coastal development can also lead to the destruction of coastal wetlands, resulting in the elimination of protective buffer zones that serve to filter sediments, nutrients, and contaminants such as heavy metals and pesticides that are transported to the coastal zone in ground and surface waters. In addition, hydrological modifications associated with coastal development alter freshwater inflow to coastal waters, resulting in changes in salinity, temperature, and nutrient regimes, and thereby contributing to further degradation of estuarine and nearshore marine habitats. The variety of pollutants and the severity of their effects from coastal development activities depend upon a number of factors, such as the nature of the construction, physical characteristics of the site involved, and proximity of the pollutant source to the coastline. However, all of these factors ultimately can serve to degrade estuarine and coastal water quality to some degree in terms of dissolved oxygen levels, salinity concentrations, and contaminants.

Conservation measures:

- Adverse impacts resulting from construction should be avoided whenever practicable alternatives are identified. For those impacts that cannot be avoided, minimization through implementation of best management practices should be employed. For those impacts that can neither be avoided nor minimized, compensation through replacement of equivalent functions and values should be required.

- Coastal development traditionally has involved dredging and filling of shallows and wetlands, hardening of shorelines, clearing of riparian vegetation, and other activities that adversely affect the habitats of living marine resources. Mitigative measures should be required for all development activities with the potential to degrade billfish EFH whether conducted in EFH or in areas that influence billfish EFH.

- Destruction of wetlands and shallow coastal water habitats should not be permitted in areas adjacent to billfish EFH. Mitigation or compensation measures should be employed where destruction is unavoidable.

- Flood control projects in waterways draining into EFH should be designed to include mitigation measures and constructed using Best Management Practices (BMPs). For example, stream relocation and channelization should be avoided whenever practicable. However, should no practicable alternatives exist, relocated channels should be of comparable length and sinuosity as the natural channels they replace to maintain the quality of water entering receiving waters (i.e., billfish EFH).

- Watershed protection/site development should be encouraged. Comprehensive planning for development on a watershed scale (and for small-scale site development as well) should be undertaken, including planning and designing to protect sensitive ecological areas, minimizing land disturbances and retaining natural drainage and vegetation whenever possible. To be truly effect, watershed planning efforts should include existing facilities even though they are not subject to EFH consultation.

- Pollution prevention activities, including techniques and activities to prevent non-point source pollutants from entering surface waters should be implemented. Primary emphasis should be placed on public education to promote methods for proper disposal and/or recycling of hazardous chemicals, management practices for lawns and gardens, onsite disposal systems (OSDSs), and commercial enterprises such as service stations and parking lots.

- Construction erosion/sediment control measures should be used to reduce erosion and transport of sediment from construction sites to surface water. A sediment and erosion control plan should be developed and approved prior to land disturbance.

- Runoff from new development should be managed so as to meet two conditions: (1) The average annual total suspended solids loadings after construction is completed are no greater than pre-development loadings; and (2) To the extent practicable, post-development peak runoff rate and average volume are maintained at levels that are similar to pre-development levels.

- Construction site chemical control measures should address the transport of toxic chemicals to surface water by limiting the application, generation, and migration of chemical contaminants (i.e., petrochemicals, pesticides, nutrients) and providing proper storage and disposal.

- New onsite disposal systems (OSDS) should be built to reduce nutrient/pathogen loadings to surface water. OSDS are to be designed, installed and operated properly and to be situated away from open waterbodies and sensitive resources such as wetlands, and floodplains. Protective separation between the OSDS and the groundwater table should be established. The OSDS unit should be designed to reduce nitrogen loadings in areas where surface waters may be adversely affected. Operating OSDSs should prevent surface water discharge and reduce pollutant loadings to ground water. Inspection at regular intervals and repair or replacement of faulty systems should occur.

- Roads, highways, bridges and airports should be situated away from areas that are sensitive ecosystems and susceptible to erosion and sediment loss. The siting of such structures should not adversely impact water quality, should minimize land disturbances, and should retain natural vegetation and drainage features.

- Construction projects of roads, highways, bridges and airports should implement approved erosion and sediment control plans prior to construction, to reduce erosion and improve retention of sediments onsite during and after construction.

- Construction site chemical control measures for roads, highways, and bridges should limit toxic and nutrient loadings at construction sites by ensuring the proper use, storage, and disposal of toxic materials to prevent significant chemical and nutrient runoff to surface water.

- Operation and maintenance should be developed for roads, highways, bridges, and airports to reduce pollutant loadings to receiving waters during operation and maintenance.

- Runoff systems should be developed for roads, highways, bridges, and airports to reduce pollutant concentrations in runoff from existing roads, highways, and bridges. Runoff management systems should identify priority pollutant reduction opportunities and schedule implementation of retrofit projects to protect impacted areas and threatened surface waters.

- The planning process for new and maintenance channel dredging projects should include an evaluation of the potential effects on the physical and chemical characteristics of surface waters that may occur as a result of the proposed work and reduce undesirable impacts. When the operation and maintenance programs for existing modified channels are reviewed, they should identify and implement any available opportunities to improve the physical and chemical characteristics of surface waters in those channels.

- Bridges should be designed to include collection systems which convey surface water runoff to land-based sedimentation basins.

- Sewage treatment discharges should be treated to meet state water quality standards. Implementation of up-to-date methodologies for reducing discharges of biocides (e.g. chlorine) and other toxic substances is encouraged.

- Use of land treatment and upland disposal/storage techniques of solid waste from sewage treatment should be implemented where possible. Use of vegetated wetlands as natural filters and pollutant assimilators for large scale wastewater discharges should be limited to those instances where wetlands have been specifically created for this purpose. The use of such constructed wetlands for water treatment should be encouraged wherever the overall environmental and ecological suitability of such an action can been demonstrated.

- Sewage discharge points in coastal waters should be located well away from critical habitats. Proposals to locate outfalls in coastal waters must be accompanied by hydrographic studies that demonstrate year round dispersal characteristics and provide proof that effluents will not reach or affect fragile and productive habitats.

- Dechlorination facilities or lagoon effluent holding facilities should be used to destroy chlorine at sewage treatment plants.

- No toxic substances in concentrations harmful (synergistically or otherwise) to humans, fish, wildlife, and aquatic life should be discharged. The EPA's Water Quality Criteria Series should be used as guidelines for determining harmful concentration levels. Use of the best available technology to control industrial waste water discharges should be required in areas adjacent to habitats essential to billfish. Any new potential discharge that will influence billfish EFH must be shown not to have a harmful effect on billfishes or their habitat.

- The siting of industries requiring water diversion and large-volume water withdrawals should be avoided in areas influencing billfish EFH. Project proponents should demonstrate that project implementation will not negatively affect billfishes, their EFH, or their food supply. Where such facilities currently exist, best management practices should be employed to minimize adverse effects on the environment.

- All NPDES permits should be reviewed and strictly enforced in areas affecting billfish EFH.

- Hazardous waste sites should be cleaned up (i.e., remediated) to prevent contaminants from entering aquatic food chains.

- Remedial actions affecting aquatic and wetland habitats should be designed to facilitate restoration of ecological functions and values.

4.4.2.3 Dredging and Placement of Dredge Material

Dredging operations occur in estuaries, nearshore areas, and offshore, in order to maintain certain areas for activities such as shipping, boating, construction of infrastructure (e.g., offshore oil and gas pipelines), and marine mining. Placement or disposal of the dredged material takes place in designated open water disposal areas, often near the dredge site. These operations can result in negative impacts on the marine environment. Of particular concern regarding billfishes that move inshore is the temporary degradation of water quality due to the resuspension of bottom materials, resulting in water column turbidity, potential contamination due to the release of toxic substances (metals and organics), reduced oxygen levels due to the release of oxygen-consuming substances (e.g., nutrients, sulfides). Even with the use of approved practices and disposal sites, ocean disposal of dredged materials is expected to cause environmental harm since contaminants will continue to be released, and localized turbidity plumes and reduced oxygen zones will persist.

Conservation measures:

- Best engineering and management practices (e.g., seasonal restrictions, modified dredging methods, disposal options) should be employed for all dredging and in-water construction projects. Such projects should be permitted only for water dependent purposes when no feasible alternatives are available. Mitigating or compensating measures should be employed where significant adverse impacts are unavoidable. Project proponents should demonstrate that project implementation will not negatively affect billfishes, their EFH, or their food sources.

- Project guidelines should make allowances to cease operations or take additional precautions to avoid adversely affecting billfish EFH during seasons when sensitive billfish life stages might be most susceptible to disruption (e.g., seasons when spawning is occurring).

- When projects are considered and in review for open water disposal permits for dredged material, Federal permitting agencies should identify the direct and indirect impacts such projects may have on billfish EFH.

- Uncontaminated dredged material may be viewed as a potentially reusable resource if properly placed and beneficial uses of these materials should be investigated. Materials that are suitable for beach nourishment, marsh construction or other beneficial purposes should be utilized for these purposes as long as the design of the project minimizes impacts to billfish EFH.

- "Beneficial Use" proposals in areas of billfish EFH should be compatible with existing uses by billfishes. If no beneficial uses are identified, dredged material should be placed in contained upland sites. The capacity of these disposal areas should be used to the fullest extent possible. This may necessitate dewatering of the material or increasing the elevation of embankments to augment the holding capacity of the site. Techniques could be applied that render dredged material suitable for export or for use in re-establishing wetland vegetation.

- No unconfined disposal of contaminated dredge material should be allowed in billfish EFH.

- Disposal sites should be located in uplands when possible.

4.4.2.4 Agriculture (and Silviculture)

Agricultural and silvicultural practices can affect estuarine and coastal water quality through nutrient enrichment and chemical contamination from animal wastes, fertilizers, pesticides and other chemicals via non-point source runoff or via drainage systems that serve as conduits for contaminant discharge into natural waterways. In addition, uncontrolled or improper irrigation practices can contribute to non-point source pollution, and may exacerbate contaminant flushing into coastal waters. Major impacts also include nutrient over-enrichment with subsequent deoxygenation of surface waters, algal blooms, which can also produce hypoxic or anoxic conditions, and stimulation of toxic dinoflagellate growth. Excessively enriched waters often will not support fish, and also may not support food web assemblages and other ecological assemblages needed to sustain desirable species and populations. Agricultural activities also can increase sediment transport in adjacent water bodies, resulting in high turbidity. Many of these same concerns may apply to silviculture, as well.

Conservation measures:

- EPA and appropriate agencies should establish and approve criteria for vegetated buffer strips in agricultural areas that may affect billfish EFH to minimize pesticide, fertilizer, and sediment loads to these areas critical for billfish survival. The effective width of these vegetated buffer strips should vary with slope of terrain and soil permeability.

- The Natural Resources Conservation Service and other concerned Federal and state agencies should conduct programs and demonstration projects to educate farmers on improved agricultural practices that would minimize the use and wastage of pesticides, fertilizers, and top soil and reduce the adverse effects of these materials on billfish EFH.

- Delivery of sediment from agricultural lands to receiving waters should be minimized. Land owners have a choice of one of two approaches: (1) apply the erosion component of the U.S. Department of Agricultures Conservation Management System through such practices as conservation tillage, strip cropping, contour farming, and terracing, or (2) design and install a combination of practices to remove settleable solids and associated pollutants in runoff for all but the largest storms.

- New confined animal facilities and existing confined animal facilities should be designed to limit discharges to waters of the U. S. by storing wastewater and runoff caused by all storms up to and including the 25-year frequency storms. For smaller existing facilities, the management systems that collect solids, reduce contaminant concentrations, and reduce runoff should be designed and implemented to minimize the discharge of contaminants in both facility wastewater and runoff caused by all storms up to and including 25-year frequency storms.

- Stored runoff and solids should be managed through proper waste utilization and use of disposal methods which minimize impacts to surface/ground water.

- Development and implementation of comprehensive nutrient management plans should be undertaken, including development of a nutrient budget for the crop, identification of the types and amounts of nutrients necessary to produce a crop based on realistic crop yield expectations, and an identification of the environmental hazards of the site.

- Pesticide and herbicide management should minimize water quality problems by reducing pesticide use, improving the timing and efficiency of application (not within 24 hours of expected rain or irrigation), preventing backflow of pesticides into water supplies, and improving calibration of pesticide spray equipment. Improved methods should be used such as integrated pest management (IPM) strategies. IPM strategies include evaluating current pest problems in relation to the cropping history, previous pest control measures, and applying pesticides only when an economic benefit to the producer will be achieved, i.e., application based on economic thresholds. If pesticide applications are necessary, pesticides should be selected based on consideration of their environmental impacts such as persistence, toxicity, and leaching potential.

- Upland erosion should be reduced by either applying the range and pasture components of a Conservation Management System, or maintaining the land in accordance with the activity plans established by either the Bureau of Land Management or the Forest Service. Such techniques include the restriction of livestock from sensitive areas through locating salt, shade, and alternative drinking sources away from sensitive areas, and providing livestock stream crossings.

- Irrigation systems that deliver necessary quantities of water yet reduce nonpoint pollution to surface waters and groundwater should be developed and implemented.

- BMPs should be implemented to minimize habitat impacts when agricultural ditches are excavated through wetlands that drain to billfish EFH.

- NPDES/SPDES permits, in consultation with state fishery agencies, should be required for agricultural ditch systems that discharge into areas adjacent to billfish EFH.

4.4.2.5 Aquaculture

Aquaculture is an expanding industry in the U.S., with most facilities located in farmland, tidal, intertidal and coastal areas. Aquaculture related impacts that adversely affect the chemical and biological nature of coastal ecosystems include discharge of excessive waste products and the release of exotic organisms and toxic substances. Problems resulting from the introduction of food and fecal wastes may be similar to those resulting from certain agricultural activities. However, greater nutrient input and localized eutrophic conditions are currently the most probable environmental effect of aquaculture activities. Extremely low oxygen levels and fish kills have been known to occur in impounded wetlands where tidal and wind circulation are severely limited and the enclosed waters are subject to solar heating. In addition, there are impacts related to the dredging and filling of wetlands and other coastal habitats, as well as other modifications of wetlands and waters through the introduction of pens, nets, and other containment and production devices.

Conservation measures:

- Mariculture operations should be located, designed and operated to reduce, prevent, or eliminate adverse impacts to estuaries and marine habitats and native fishery stocks. These impacts that cannot be eliminated must be fully mitigated in-kind.

- Mariculture facilities should be operated in such a manner that minimizes impacts to the local environment by utilizing water conservation practices and effluent discharge standards that protect existing designated use of receiving water.

- Federal and state agencies should cooperatively promulgate and enforce regulations to ensure both the health of the aquatic organism and quality of the food products. Animals that are to be moved from one biogeographic area to another or to natural waters should be quarantined to prevent disease transmission.

- To prevent disruption of natural aquatic communities cultured organisms should not be allowed to escape, the use of organisms native to each facility's region is strongly encouraged.

- When commercially cultured fish are considered for stocking in natural waters, every consideration should be given to protecting the genetic integrity of native fishes.

- Aquaculture facilities should meet prevailing environmental standards for wastewater treatment and sludge control.

4.4.2.6 Navigation

Navigation-related threats to estuarine, coastal, and offshore environments that have the potential to affectbillfish EFH include navigation support activities such as excavation and maintanance of channels (including disposal of excavated sediments), which results in the elevation of turbidity and resuspension of contaminants; construction and operation of ports, mooring and cargo facilities; construction of ship repair facilities; construction of channel stabilization structures such as jetties and revetments. In offshore locations, the disposal of dredged materials is the most significant navigation related threat, resulting in localized burial of benthic communities and degradation of water quality. In addition, threats are posed by vessel operation activities which include discharge and spillage of oil and other hazardous materials, trash and cargo; introduction of exotic species through ballast water exchange; and exacerbation of shoreline erosion due to wakes.

Conservation measures:

- Permanent dredged material disposal sites should be located in upland areas. Where long-term maintenance is anticipated, upland disposal sites should be acquired and maintained for the entire project life.

- Construction techniques (e.g. silt curtains) must minimize turbidity and dispersal of dredged materials into billfish EFH.

- Propwashing is generally not a recommended dredging method.

- Channels and access canals should not be constructed in areas known to have high sediment contamination levels. If construction must occur in these areas, specific techniques including the use of silt curtains will be needed to contain suspended contaminants.

- Alignments of channels and access canals should utilize existing channels, canals and other deep water areas to minimize initial and maintenance dredging requirements. All canals and channels should be clearly marked to avoid damage to adjacent bottoms from propwashing.

- Access channels and canals should be designed to ensure adequate flushing so as not to create low-dissolved oxygen conditions or sumps for heavy metals and other contaminants. Widths of access channels in open water should be minimized to avoid impacts to aquatic bottoms. In canal subdivisions, channels and canals within the development should be no deeper than the parent body of water and should be of a uniform depth or become gradually shallower inland.

- To ensure adequate circulation, confined and dead-end canals should be avoided by utilizing bridges or culverting that ensures exchange of the entire water column. In general, depths of canals should be minimized, widths maximized and canals oriented towards the prevailing summer winds to enhance water exchange.

- Consideration should be given to the use of locks in navigation channels and access canals which connect more saline areas to fresher areas.

- To the maximum extent practicable, all navigation channels and access canals should be backfilled upon abandonment and restored to as near pre-project condition as possible. Plugs, weirs or other water control structures may also be necessary as determined on a case-by-case basis.

- All vessels transporting fuels and other hazardous materials should be required to carry equipment to contain and retrieve the spill.

- Dispersants should not be used to clean up fuels and hazardous materials unless approved by the EPA/Coast Guard after consultation with fisheries agencies.

4.4.2.7 Marinas and Recreational Boating

Marinas and recreational boating are increasingly popular uses of coastal areas. As marinas are located at the water's edge, there is often no buffering of the release of associated pollutants into the water column. Impacts caused by marinas include lowered dissolved oxygen, increased temperatures, bioaccumulation of pollutants by organisms, toxic contamination of water and sediments, resuspension of sediments and toxics during construction, eutrophication, change in circulation patterns, shoaling, and shoreline erosion. Pollutants that result from marina activities include nutrients, metals including copper released from antifouling paints, petroleum hydrocarbons, pathogens, and polychlorinated biphenyls. Also, chemicals commonly used to treat timber used for piers and bulkheads - creosote, copper, chromium, and arsenic salts - are introduced into the water. Other impacts associated with recreational boating are the result of improper sewage disposal, fuel and oil spillage, and cleaning operations, and fish waste. Propellers from boats can also cause direct damage to multiple life stages of organisms, including eggs, larvae, and juveniles; destratification; elevated temperatures, and increased turbidity and contaminants by resuspending bottom materials.

Conservation measures:

- Water quality must be considered in the siting and design of both new and expanding marinas.

- Marinas are best created from excavated uplands that are designed so that water quality degradation does not occur. Applicants should consider basin flushing characteristics and other design features such as surface and waste water collection and treatment facilities. Marina siting and design should allow for maximum flushing of the site. Adequate flushing reduces the potential for the stagnation of water in a marina and helps to maintain the biological productivity and reduce the potential for toxic accumulation in bottom sediment. Catchment basins for collecting and storing runoff should be included as components of the site development plan.

- Marinas should be designed and located so as to protect against adverse impacts to important habitat areas as designated by local, state, or federal governments.

- Where shoreline erosion is a nonpoint source pollution problem, shorelines should be stabilized. Vegetative methods are strongly preferred.

- Runoff control strategies, which include the use of pollution prevention activities and the proper design of hull maintenance areas, should be implemented at marina sites.

- Marinas with fueling facilities should be designed to include measures for reducing oil and gas spillage into the aquatic environment. Fueling stations should be located and designed so that, in the case of an accident, spill contaminants can be contained in a limited area. Fueling stations should have fuel containment equipment as well as a spill contingency plan.

- To prevent the discharge of sewage directly to coastal waters, new and expanding marinas should install pumpout, pump station, and restroom facilities where needed.

- Solid wastes produced by the operation, cleaning, maintenance, and repair of boats should be properly disposed of to limit their entry to surface waters.

- Appropriate storage, transfer, containment, and disposal facilities for liquid materials commonly used in boat maintenance along with the encouragement of recycling of these materials, should be required.

- The amount of fuel and oil leakage from fuel tank air vents should be reduced.

- Potentially harmful hull cleaners and bottom paints and their release into marinas' and coastal waters should be minimized.

- Public education/outreach/training programs should be instituted for boaters, as well as marina operators, to prevent improper disposal of polluting materials.

- Pumpout facilities should be maintained in operational condition and their use should be encouraged to reduce untreated sewage discharges to surface waters.

4.4.3 Cumulative Impacts

Cumulative impacts on the environment are those that result from the incremental impact of actions added to other past, present and reasonably foreseeable future actions. Such cumulative impacts generally occur in inshore and estuarine areas, and can result from individually minor, but collectively significant, actions taking place over a period of time. These impacts include water quality degradation due to nutrient enrichment, other organic and inorganic contaminants associated with coastal development, and activities related to marine transportation, and loss of coastal habitats, including wetlands and sea grasses. The rate and magnitude of these human-induced changes on EFH, whether cumulative, synergistic, or individually large, is influenced by natural parameters such as temperature, wind currents, rainfall, salinity, etc. Consequently, the level of threat posed by a particular activity or group of activities may vary considerably from location to location. These multiple effects can, however, result in adverse impacts to billfishes that range both offshore and into coastal waters.

Nutrient enrichment has become a large cumulative problem for many coastal waters. Nutrient loading results from the individual activities of coastal development, non-point source pollution, marinas and recreational boating, sewage treatment and disposal, industrial wastewater and solid wastes, ocean disposal, agriculture and aquaculture. Excess nutrients from land based activities may accumulate in the soil, be transported through the atmosphere, pollute ground water, or move into streams and coastal waters. Nutrient inputs are known to have a direct effect on water quality. For example, in extreme conditions excess nutrients can stimulate excessive algal blooms or dinoflagellate growth that can lead to increased metabolism and turbidity, decreased dissolved oxygen, and changes in community structure, a condition known as eutrophication. Examples of such dinoflagellates or algae include *Gynodinium breve* the dinoflagellate that causes neurotoxic shellfish poisoning, dinoflagellates of the genus *Alexandrium* which causes paralytic shellfish poisoning, *Aureococcus anophagefferens* the algae which causes "Brown tide", and diatoms of the genus *Pseudo-nitzschia* which causes amnesic shellfish poisoning. A *Pfiesteria piscicida*-like organism has been documented in St. John's River, Florida. This organism has been associated with fish kills in some areas.

In addition to the direct cumulative effects incurred by development activities, inshore and coastal habitiats are also jeopardized by persistent increases in certain chemical discharges. The combination of incremental losses of wetland habitat, changes in hydrology, and nutrient and chemical inputs produced over time can be extremely harmful to marine and estuarine biota, resulting in diseases and declines in the abundance and quality of the affected resources.

Future investigations will seek to analyze cumulative impacts to specific geographic locations (certain estuaries, coastal and offshore habitats) in order to evaluate the cumulative impacts to billfish EFH. Information and techniques that are developed for this process will be used to supplement future revisions of these EFH provisions as the information becomes available.

Conservation measures:

Conservation measures for individual activities that are included under cumulative impacts are covered in the previous sections. Participation in watershed scale planning efforts should be encouraged.

4.5 Habitat Research Plans and Information Needs

During the identification of EFH for the billfishes covered in this amendment, numerous information gaps were also identified. This was not unexpected considering the oceanic range and pelagic nature of these fishes. In many cases, the movements of these animals are poorly understood or have only been defined in broad terms. Furthermore, although the habitats through which these animals transit may be intensely studied, and the physical and biological processes fairly well understood in broad terms, there is little understanding of the particular characteristics that influence the distribution of billfish within that system. Unlike many estuarine or coral reef species that can be easily observed, collected or cultured, the extensive mobility and elusiveness of the species combined with their rarity has delayed the generation of much of the basic biological and ecological information needed to analyze their habitat affinities. Moreover, there is a general lack of technology to study habitat associations of these species *in situ*, as well as in laboratory cultures.

Based on the present state of information concerning the habitat associations of billfishes, the following research and information needs have been identified. The NMFS National Habitat Research Plan lays out a framework within which research priorities may be grouped. Many of the research and information needs for the billfishes fit well within that plan and it has been used to define general topics for research and information collection:

Ecosystem Structure and Function

- Investigate the influence of habitat characteristics such as temperature (e.g., the relation to thermal fronts) and salinity on billfish distributions, spatially as well as seasonally.

- Monitor animal movements using advanced archival and satellite telemetry technology in order to better define billfish distributions, seasonality, environmental tolerances and preferred habitats.

- Identify spawning areas and investigate the role of environmental factors which affect distribution and survival of larvae and juveniles leading to variations in year class abundance.

- Characterize submarine canyon processes, eddies, gyres, and fronts as they are associated with billfishes and their importance as zones of aggregation.

- Further identify major prey species for each species of billfish, including preferred feeding areas and influences of environmental factors.

- Gain a better understanding of the life history of the billfish species; including the development of culture methods to keep billfish alive in captivity for life history studies.

- Improve the capability to identify eggs and early life stages of the billfish species.

Effects of Habitat Alteration

- Investigate the effects of contaminants on billfish life stages, especially eggs and larvae; this would involve development of better laboratory culture techniques for these species.

- Determine the effects of contaminants (e.g., oil spills) in offshore epipelagic habitats where billfishes are known to aggregate.

- Identify habitat linkages between inshore and offshore habitats to better define the zone of influence for inshore activities that may adversely affect billfish habitats.

Synthesis and Information Transfer

- Incorporate/develop spatially consistent databases of environmental conditions throughout the billfishes' ranges (T, S, currents).

- Further analyze fishery dependent data to construct a clearer view of relative abundances.

- Contour abundance information to better visualize areas where bill fish are most commonly encountered.

- Construct spatial databases for early life history stages (eggs and larvae).

- Derive objective criteria to model areas of likelihood for relative abundances of billfish based on environmental parameters.

- Define and model habitat suitability based on seasonal analyses of tolerances of environmental conditions.

4.6 Review and Revision

Throughout the preparation of this document, numerous sources of information have been identified. Some of these have been accessed and incorporated into the identification and description of billfish EFH for this amendment. These sources include fishery scientists both inside and outside of NMFS and databases maintained in the Miami Science Center- SEFSC (e.g., Billfish, Pelagic Logbook, Observer programs, Large Pelagic Survey, etc.). The most up-to-date and reliable information available was used to describe and identify EFH for billfishes in this amendment. NMFS will continue to identify other sources of information that can be incorporated into these analyses to further refine EFH. Other data sources might include programs such as state habitat characterization and mapping programs (e.g., those being conducted in Florida and Texas), ichthyoplankton sampling efforts for the Gulf of Mexico and other on-going investigations that will provide additional insight into the distribution of billfishes. The Release and Recapture (CTC) databases used for this amendment are part of a continuing effort to monitor these fisheries over broad spatial scales. They are continually being updated with newly reported information and are being scrutinized to ensure that a high standard is maintained. Additional analytical techniques and database queries will be possible to more fully evaluate trends and patterns in the data such as seasonal, interannual and interdecadal variations. Because the database incorporates such a long time series of data, it may allow for additional investigation of the historic ranges and temporal changes in species distributions.

NMFS is committed to monitoring and participating in these on-going research efforts in order to update the information in the EFH provisions of this amendment. New and updated information, if available, will be reviewed as part of the annual Stock Assessment and Evaluation (SAFE) report prepared by NMFS. If the additional information provides significant improvement over the current document, the amendment will be revised to refine the EFH descriptions, identification, conservation and enhancement and/or threats sections of the EFH provisions of this management plan.

4.7 Description of Fishing Activities

4.7.1 History of Exploitation

Atlantic billfish have historically been landed as the incidental catch of foreign and domestic commercial pelagic longline vessels, or in directed recreational and subsistence handline fisheries. Since the majority of billfish fishing mortality in the Atlantic Ocean is part of international commercial pelagic fisheries (Figures 4.7.1, 4.7.2 and 4.7.3; Appendix F, Tables 1, 2 and 3), billfish catch estimates have risen and fallen with the overall catch estimates for pelagic fisheries. Recorded Atlantic blue marlin landings (Figure 4.7.4) were at their peak (9,000 mt) in 1963, after which they declined and stabilized through the late 1970s (2,000 - 3,000 mt). From the late 1970s through the late 1980s, landings declined again to generally between 1,300 - 2,700 mt, until beginning a pattern of increase and fluctuation (3,000-4,400 mt) from 1989 through the mid-1990s. White marlin landings in the North Atlantic (Figure 4.7.5) have followed a fluctuating pattern similar to blue marlin landings. Total reported landings in the Atlantic for white marlin peaked in 1965 at 5,000 mt, declining and fluctuating to 900 mt by 1980. Those numbers have risen and fluctuated between 1,300-1,900 mt over the past ten years. Atlantic longline catches of sailfish and longbill spearfish have been reported together in ICCAT landing statistics (except for Japan since 1994), therefore these species have been summarized together in Figure 4.7.6. Landings for sailfish/spearfish reached a peak in the Atlantic of almost 3,000 mt in 1965, then declined to about 1,600 mt in 1973. In 1976, sailfish/spearfish landings reached a historical peak of over 6,000 mt, and have since fluctuated between 2,000 to 4,000 mt. In the western Atlantic, sailfish/spearfish landings have remained relatively stable, at nearly 1,000 mt since 1973.

In waters off of the continental United States, the primary traditional use of Atlantic billfish resources has been in recreational fisheries since the early 1900s, with a significant increase in participation after World War II. Until the early 1950s, the fishery was concentrated in only a few areas along the Atlantic and Gulf Coasts. Largely as a result of improvements in offshore sport fishing vessels and equipment since then, there has been rapid expansion in both the number of anglers and the fishing grounds utilized. Fisheries in waters off Puerto Rico, in addition to a recreational fishery, traditionally included a small-scale, handline subsistence fishery. With the exception of a small harpoon fishery for white marlin that used to exist in the waters off of southern New England, there have been no directed commercial activities geared toward billfish. However, billfish caught incidentally in commercial fisheries were marketed prior to the late 1980s, and were usually processed and sold as smoked fish product. The 1988 Atlantic Billfish FMP provided a summary of historical exploitation foreign longline fisheries within the U.S. EEZ.

4.7.2 Current Domestic Activities

Domestic fishing activity directed on Atlantic billfish is limited to recreational fishing. In 1988, the South Atlantic Fishery Management Council, in cooperation with the Caribbean, Mid-Atlantic, New England, and Gulf of Mexico Fishery Management Councils, prepared an FMP for Atlantic Billfishes, which prohibited retention, landing, or sale of billfish caught by commercial fishing vessels in U.S. waters (50 CFR part 644.23). A billfish caught on commercial gear shoreward of the outer boundary of the EEZ must be released "in a manner that will ensure maximum probability of survival," by cutting the line near the hook without removing the fish from the water. These regulations have encouraged commercial fishermen to avoid catching billfish altogether. Table 4.7.1 summarizes the percent of billfish released alive, by area, for the 1995 longline fishery. Long-term survival of billfish from longline gear is unknown; however, billfish tagged and released alive from commercial gear have been recaptured after extended periods of release (see section 4.3.1).

Conservation of Atlantic billfish resources was recognized as a primary objective by the 1988 Atlantic Billfish FMP in order to maintain the highest availability of billfishes to the U.S. recreational fishery. Atlantic billfish regulations set minimum size limits for the retention of billfish species by any recreational fishermen: 86 inches LJFL for blue marlin and 62 inches LJFL for white marlin, as well as a 57 inch LJFL minimum size for sailfish, with no minimum size limit for longbill spearfish. The minimum sizes for retention were generally above minimum size of maturity, except for sailfish. The March, 1988 interim rule increased the minimum size to 96 inches LJFL for blue marlin, and 66 inches LJFL for white marlin; the interim rule was extended in September, 1998, with and additional increase in the minimum size of blue marlin to 99 inches LJFL and institution of a one marlin per vessel per day bag limit. The recreational fishing community has actively encouraged its members to release their live billfish catches, so as to better conserve the resource for future anglers. Fisher and Ditton (1992) estimated that 89 percent of all billfish caught by anglers who participate in tournaments are released (whether or not that fish was caught during a tournament), depending upon area fished (Table 4.7.2). However, there are few statistically-valid estimates of the survival rate of billfish that have been caught and released in recreational fisheries, making estimates of fishing-induced mortality difficult to assess. The few studies evaluating release mortality rates were summarized in Section 3.2.1.

4.7.2.1 Participating User Groups

In the United States, Atlantic blue marlin, white marlin, sailfish and longbill spearfish can be landed only by recreational fishermen fishing from either private or charter vessels. Recreational angling for Atlantic billfish can be sub-divided into tournament and non-tournament trips. The total population of billfish anglers has not been quantified. Social and economic studies of billfish anglers have been based on sub-sampling tournament and charter participants. Anglers fishing for billfish on private vessels and who do not also participate in either charter or tournament fishing are not accounted for in any of these studies. Social and economic studies have focused on tournament billfish fisheries in the U.S. Atlantic and in Puerto Rico. The number of vessels per tournament range from 5 to 150 per tournament, with the number of anglers ranging from 10 to 1,000 per tournament (Avrigian, pers. comm.). Ditton and Fisher (1992) completed an extensive mail survey of 1,984 billfish tournament anglers, and estimated that there were 7,915 U.S. tournament billfish anglers in the western Atlantic Ocean during 1989. The participants in the billfish fishery from their study were generally college-educated males, with a mean age of 46, median household income of $115,000 and more than 11 years of experience fishing for billfish. The economic and social characteristics of participants are discussed in further detail in sections 4.8 and 4.9, respectively.

4.7.2.2 Tournament Fishing

There are approximately 300-400 billfish tournaments per year along the U.S. Atlantic coast (including the Gulf of Mexico and Caribbean). Offshore fishing tournaments target blue marlin, with other categories for white marlin, sailfish, tuna (generally yellowfin tuna), dolphin-fish (mahi) and wahoo, generally by high-speed trolling. Sailfish tournaments, which are found almost exclusively in south Florida and the Florida Keys, operate closer to shore than most billfish tournaments and fish mostly with live bait. Billfish tournaments may be categorized into three general types. Club series tournaments are sponsored by various types of fishing clubs and usually award trophies. Rodeo and promotional tournaments are usually sponsored by a commercial concern such as a restaurant, Chamber of Commerce, group of charterboat captains or marinas. In addition, there are high profile tournament events which are characterized by large vessels and big prizes. Tournament entry fees range from $20 to $8,000, with the high-profile events being the most expensive. Fisher and Ditton (1992) found the average tournament fee in 1989 was $546 and an additional estimated expenditure of $1,600 per angler per tournament, including loading, boat operation, food, bait and tackle, transportation, and captain/charter fees. Cash prizes range from $20 to more than $100,000. In August, 1997, the Pirate Cove Billfish Tournament awarded $217,000 to the participant who landed a 670 pound blue marlin. Other prizes sometimes awarded include Rolex watches, fishing equipment, and even boats. Tournaments often involve calcuttas, which are prizes based on pooled contributions of a group of tournament participants that are won by the member of the group that catches and/or releases the largest/most fish.

4.7.2.3 Vessels and Fishing Gear

Sport fishing for Atlantic billfish on private recreational and charter vessels is done with rod and reel. The 1988 Atlantic Billfish FMP noted that boats used in the U.S. sport fishery for billfishes range from 16 feet to more than 65 feet in length, powered with outboard engines to large diesels. Lucy et al. (1990), describing the fleet characteristics in Virginia's recreational marlin-tuna fishery, found that boats averaged 28 feet in length, with charter vessels averaging 37 feet, and private boats averaging 26 feet in length. Fishing for blue marlin and white marlin generally requires a larger vessel with inboard engines because of the distance needed to travel to reach the fishing grounds. Trips in excess of 100 miles from the shore may be required to reach primary fishing areas. Sailfish tend to be found in shallower waters, closer to shore, which allows the use of smaller boats with outboard engines. In some geographical areas, where deep waters are closer to shore, vessels of all sizes targeting marlin and sailfish can be found. This is particularly evident off the southeast coast of Florida, northern Gulf of Mexico and the Caribbean (Puerto Rico and U.S. Virgin Islands). The development of more reliable engines, electronic devices (e.g., GPS, cellular phones, and satellite-based communications), and new vessel designs has made offshore fishing grounds accessible to more anglers in a greater variety of vessel sizes.

4.7.2.4 Fishing Areas and Seasons

Sport fishing for billfishes is conducted in nearly all the warm water ocean areas, generally in relatively deeper waters of tropical and subtropical areas. The recreational U.S. Atlantic billfish fishery is concentrated from Massachusetts to North Carolina, southeast Florida, the northern Gulf of Mexico and the Caribbean (including Puerto Rico and the U.S. Virgin Islands), depending upon the species and season. Blue marlin are most abundant off the mid-Atlantic coast in the summer, off the east coast of Florida and Bahamas in the spring, off Puerto Rico and the Virgin Islands in the summer and fall, and off the Florida Keys in the fall. White marlin are available to the recreational sport fisheries in the Gulf of Mexico from June into October, with peak abundance in the northern Gulf in July and August (Browder and Prince 1990). The northeastern limit of the summer coastal occurrence of white marlin is off Nantucket Island, south of eastern Cape Cod. Spring is the peak season for sport fishing for white marlin in the Straits of Florida, Bahamas, Puerto Rico and the Virgin Islands. Most of the recreational fishing effort for billfishes along the U.S. Atlantic coast, Gulf of Mexico, and in the Caribbean Sea is concentrated either around key ports, fishing centers, or billfish tournaments (Prince et al. 1990), in relatively deep waters from 120 ft to 6,000 ft (Lucy et al. 1990).

4.7.2.5 Domestic Conflicts

There have been four areas of conflict identified between recreational and commercial fishermen for Atlantic billfish resources: (1) gear conflicts, i.e., interference with the fishing operation of one user group by another; (2) conflicts that arise from real or perceived competition for the resource; (3) conflicts between user-groups arising from the need to share limited resources that are highly migratory and range well beyond the jurisdiction of any one nation; and (4) basic conflicts between user-groups based on fundamental philosophical differences in the goals in the use of the resource. The prohibition of commercial landings of billfish by the 1988 Atlantic Billfish FMP has resulted in a reduction of some of the conflicts between recreational and commercial fishermen. However, regulatory dead discards of Atlantic billfish in the pelagic longline fishery continue to be a basis of conflict between recreational and commercial fishermen. Billfish bycatch in the U.S. longline fleet has been estimated using data from mandatory pelagic logbooks (see Section 2.7.3). Observer data are used to scale logbook-reported encounters to provide a more accurate assessment of billfish bycatch. Estimates of the billfish dead discards in the U.S. commercial longline fishery for 1996 were 196.6 mt for blue marlin, 67.6 for white marlin and 71.6 mt for sailfish (Table 2.5.2). In comparison, minimimum estimates of recreational landings in 1996 for blue marlin were 34.9 mt, 3.3 mt for white marlin and 1.1 mt for sailfish. Commercial discard rates (live + dead) of all billfish species combined are shown in Figure 4.7.7 for 1987 to 1996.

The level of recreational landings is also a source of conflict. Commercial fishermen argue that recreational landings are under-reported, particularly from non-tournament sources. There is concern by the commercial community that Atlantic billfish mortality associated with catch and release is significant and should be included in determining the impact of recreational fishing. The relative magnitude of the recreational catch to commercial catch (landed until 1980; incidental 1981-1995) is shown for blue marlin and white marlin in Figures 4.7.8 and 4.7.9, respectively. The incidental catch of blue marlin, white marlin, sailfish and spearfish is summarized, by area for 1995, in Table 2.5.6. Blue marlin represented 0.49 percent of the total number of fish caught by longline gear. They were caught most frequently in the Caribbean (3.33 percent of the catch) and Offshore South (2.78 percent), but were rarely encountered off the Grand Banks or Northeast Coastal areas. White marlin represented 0.49 percent of fish caught by the 1995 longline fishery. Sailfish and spearfish are less frequently encountered by longline gear (0.2 percent and 0.07 percent of the 1995 longline catch, respectively), and are generally found in the Gulf of Mexico, southeast coastal and southern offshore regions.

Another source of conflict in the domestic Atlantic billfish fishery is the development of management strategies in consideration of the highly migratory nature of billfish, particularly blue marlin and white marlin, and the fact that such a small percentage of the stock occurs at any point in time within the U.S. EEZ (Table 2.5.1). Regulatory actions taken unilaterally by the United States, no matter how restrictive, may not have a substantial impact on the conservation of these species (Orbach 1990); however, the role of management actions taken by the United States and their impact on international negotiations through ICCAT must also be considered. The first-ever binding recommendation for conservation of billfish resources in the Atlantic (25 percent reductions in landings and improved monitoring) was made by ICCAT in 1997, largely due to the cooperative nature of U.S. recreational and commercial concerns as members of the U.S. delegation to ICCAT in negotiations with the international community.

4.7.2.6 Amount of Landings/Catches

Recreational catches of billfishes from private and charter vessels are difficult to accurately assess because billfish are relatively rare in comparison with other species targeted by marine anglers, and because there are relatively few billfish fishermen relative to the vast number of marine recreational anglers. These characteristics challenge the use of traditional recreational angler surveys (see section 2.7.3) for monitoring billfish catches. Recreational landings of billfish by U.S. billfish anglers are estimated by a combination of billfish tournament intercepts (RBS), mandatory reporting by tournaments selected by the Science Director, and the LPS. Total reported landings for blue marlin and white marlin for recreational and incidental longline dead discards are summarized in Figures 4.7.8 and 4.7.9, respectively. Reported U.S. recreational landings of blue marlin, white marlin and sailfish for 1994, 1995 and 1996 are shown by geographic area in Table 2.5.2.

The 1996 billfish assessment (SCRS, 1996) included a relative index of rod and reel catches per unit effort (CPUE) of blue marlin and white marlin caught in the United States from 1973 to 1995 (Figure 4.7.10). Although absolute catches can not be obtained from these analyses, trends in U.S. catches of these species, over time, can be delineated. CPUE for blue marlin has continued to increase since 1973, with some minor fluctuations, with the greatest increases occurring during the last two years of the time series. CPUE for white marlin has been relatively stable during the 1990s. The recreational fishery has tended to target bigger blue marlin, necessitating the use of larger baits trolled at faster speeds (SCRS 1996), which may have increased blue marlin CPUE estimates and decreased estimates of white marlin catch.

During the 1997 billfish tournament season in the Gulf of Mexico, there were 1,010 billfishes reported as hooked; 132 were kept, 388 were released (only 8.5 percent were releases without being tagged) and 490 were lost based on the Recreational Billfish Survey of 44 billfish tournaments (Avrigian pers. comm.). Of the 520 billfish reported as caught (i.e., kept or released) during the 1997 season in the northern Gulf of Mexico, about 59 percent were blue marlin, 29 percent were white marlin, 12 percent were sailfish, and less than 1 percent (N=3) were spearfish.

Fisher and Ditton (1992) estimated that there were 7,915 U.S. tournament billfish anglers in the western Atlantic Ocean during 1989, making a total of 102,895 billfish fishing trips (90 percent confidence interval = 6,512), including tournament and non-tournament participation. In 1989, these trips resulted in an estimated 42,301 billfish caught, consisting of 38 percent sailfish, 33 percent blue marlin, 29 percent white marlin, and less than 1 percent spearfish. They estimated that 5,541 billfish were landed (90 percent confidence interval = 715); of billfish landed, 59 percent were blue marlin, 24 percent were white marlin, 15 percent were sailfish, and approximately 2 percent were spearfish. In their survey targeting anglers who participate in billfish tournaments, Fisher and Ditton reported that anglers make an average of 13 billfish trips per year. The number of trips over the survey year varied by region, with the maximum number taken in the Caribbean (17.3 per year), and the least in the Gulf of Mexico (8.7 trips per year). Billfish trips averaged 2.6 days, with each angler, on average, landing less than one billfish each year. A total of 71 percent of the 1,171 anglers responding in the Fisher and Ditton study indicated that they did not land a billfish during the year of the survey, therefore 29 percent of anglers accounted for all angler-induced mortality. During 1989, it took an average of 6.3 days of fishing to boat a billfish. Mid-Atlantic anglers caught the most billfish per angler (2.16), and had the highest release rate (95 percent) and lowest retention rate per angler (0.11)(Table 4.7.2). Gulf of Mexico anglers caught the fewest billfish per angler (0.83), and Caribbean anglers had the highest retention rate per angler.

4.7.3 Current Foreign Fishing Activities

4.7.3.1 Participating Nations

Atlantic blue marlin, white marlin and sailfish are a highly-prized recreational species in the United States, Venezuela, Bahamas, Brazil and many countries in Caribbean Sea and west coast of Africa. They are also landed by many countries for consumption from incidental catches to directed commercial longline fisheries. The directed effort is principally targeted toward tuna species and swordfish; however, billfishes occur in the same area as these other pelagic species, making them susceptible to this gear. Because billfish are largely daylight feeders, they tend to be associated more with tuna catches rather than swordfish. Nations currently fishing throughout the

Atlantic for tuna and swordfish, and reporting catches of Atlantic billfish are Chinese Taipei[1], Japan and Korea. Countries reporting catches of billfish just from the north Atlantic management area (for blue marlin and white marlin) include Barbados, Cuba, Spain, Granada, Netherlands-Antilles, Trinidad and Tobago, United States and Venezuela. In the south Atlantic, billfish catches have recently been reported by Brazil, Brazil-Taiwan (a joint-venture between the countries of Brazil and Taiwan), Cote d'Ivoire and Ghana in addition to those countries fishing throughout the Atlantic. Countries reporting catches of sailfish and longbill spearfish from the western Atlantic management unit include Barbados, Brazil, Brazil-Taiwan, Dominican Republic, Grenada, Korea, Trinidad and Tobago, United States and Venezuela SCRS, 1997).

4.7.3.2 Vessels and Fishing Gear

The foreign commercial fisheries that interact with Atlantic billfish are primarily pelagic longline fleets. Foreign vessels tend to be larger than those used by U.S. fishermen because of the distances from home port and time spent at sea. The primary fishing line, or mainline of the longline system, can vary from 15 to 50 miles in length, with approximately 20 to 30 hooks per mile. The depth of the mainline is determined by the length of the float-line, which connects the mainline to several buoys and an occasional marker with radar reflector. Each individual hook is connected by a gangion to the mainline.

4.7.3.3 Fishing Areas

Longline fishing by foreign vessels within the U.S. Atlantic EEZ is not permitted. The foreign longline fishery operates throughout the range of Atlantic billfishes outside of the U.S EEZ (see Sections 2.3 and 4.1), with fishing efforts concentrated on areas of highest concentrations (see Section 4.2).

4.7.3.4 Enumeration of Recent Catches as Distributed Among the Stocks Comprising the Management Unit.

A total of 27 different countries have reported catches[2] of blue marlin from the Atlantic Ocean (Appendix F, Table 1) since 1963; 21 countries in the north Atlantic and 13 in the south Atlantic (7 countries fished both areas) reported blue marlin catches. The combined reported catches of blue marlin from the total Atlantic, north and south Atlantic are shown in Figure 4.7.4. Historically, Japan was responsible for nearly 95 percent of the blue marlin catches through 1996, peaking in 1963 with 8,600 mt (4,759 mt in the north Atlantic and 3,841 mt in the south Atlantic). During the 1970s and 1980s, Japan, Cuba, Korea, Chinese Taipei and the United States

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[1]Chinese Taipei is used by ICCAT to designate the cooperative efforts of China and Taiwan.

[2]ICCAT defines catches as reported landings by member countries; the U.S. reports both dead discards from commercial fishing efforts and estimated landings from recreational fisheries. The sum of these values is the U.S. "catch" reported by ICCAT.

dominated catches in the north Atlantic, accounting for nearly 80 percent of all blue marlin caught. In 1996 (year of most recent data), Japan (42.5 percent), Chinese Taipea (13.7 percent) and the United States (12.4 percent, including recreational landings and longline dead discards) reported the highest catches (Table 4.7.3). In the south Atlantic during the late 1960s and 1970s, blue marlin were caught most frequently by Japan, Cuba, Chinese Taipei and Korea (approximately 90 percent), with catches from Japan dropping off after 1973. During the 1980s, Japan increased its participation in the south Atlantic, along with Cote d'Ivoire. Most recently, Chinese Taipei, Cote d'Ivoire, Ghana, Japan and Brazil-Taiwan have accounted over 80 percent of the increasing catches of blue marlin.

White marlin have been caught by 33 different countries in the Atlantic since 1963 (Appendix F, Table.2). The combined reported catches of white marlin from the total Atlantic, north and south Atlantic are shown in Figure 4.7.5. As noted for the blue marlin, Japan was responsible for nearly 95 percent of all white marlin caught in the Atlantic Ocean during the 1960s, with a peak catch of 4,631 mt in 1965 (1,913 mt in the north Atlantic and 2,718 mt in the south Atlantic). In the north Atlantic, 16 countries have reported catches of white marlin, with Chinese Taipei, Japan, Cuba, Venezuela, Korea and the United States (recreational landings and commercial discards after 1988) reporting the highest catches during the 1970s and 1980s. In 1996, Chinese Taipei (25.5 percent), Venezuela (21.7 percent) and Japan (18.3 percent) provided the greatest catch of white marlin in the north Atlantic (Table 4.7.3). Japan, Korea, Chinese Taipei and Brazil were the most frequent countries of the 17 reporting catches of white marlin in the south Atlantic. After Japan reduced catches of white marlin in the south Atlantic in 1973, Korea, Chinese Taipei and Cuba were responsible for nearly 90 percent of the landings. In 1996, the country of Gabon (38.1 percent) has recently has become second, to Chinese Taipei (42.5 percent), in catches of white marlin in the south Atlantic (Table 4.7.3).

A total of 32 countries have reported catches of Atlantic sailfish and spearfish from the Atlantic (Appendix F, Table 3). The combined reported catches of sailfish and spearfish from the total Atlantic, east and west Atlantic are shown in Figure 4.7.6. In the eastern Atlantic, 14 countries have reported catches of sailfish and spearfish, with Japan reporting the highest catches during the 1960s, being replaced by much higher catches by Ghana during the 1970s and 1980s (peak of 4,726 mt in 1975). Since the late 1980s, catches of sailfish and spearfish have fluctuated around 2,500 mt, with the largest catches during the 1990s coming from Senegal, Ghana and Cote d'Ivoire. A total of 25 countries have reported catches of sailfish and spearfish from the western Atlantic, including Japan, Korea, Brazil, United States, Venezuela, Dominican Republic, Cuba and Chinese Taipei. The top three countries during 1996 (Table 4.7.3) were Brazil (29.7 percent), Venezuela (16.7 percent), and Trinidad and Tobago (11.3 percent).

4.7.4 Interactions Between Foreign and U.S. Participants

Title II of the Magnuson-Stevens Act establishes the system for the regulation of foreign fishing within the U.S. EEZ. These regulations are published in 50 CFR 611. The regulations provide for the setting of a total allowable level of foreign fishing (TALFF) for specific species based on the portion of the optimum yield that will not be caught by U.S. vessels. At the present time, no TALFF is available, since the United States has the capacity to harvest up to the level of optimum yield of all species subject to this fishery management plan. One objective of this FMP is to match domestic fleet capacity with resource status (and thus, available quota) suggesting that no TALFF is likely to be available during or following rebuilding of overfished HMS stocks.

The 1988 Atlantic Billfish FMP described competition for billfish resources between the U.S. recreational fishery and foreign commercial fisheries. Although the gear conflicts with foreign longline gear within the U.S. EEZ have been resolved since that time, the issue of billfish catches by foreign fisheries and the resultant impact on the status of the stock is still a concern to U.S. fishery managers and all stakeholder groups. The relative biomass estimates for blue marlin (Figure 4.1.1) indicate that the stock in the total Atlantic has not improved, but has continued to decline since the 1988 FMP; blue marlin in the north Atlantic have shown some improvement (Figure 4.1.3), but are still at only 61 percent of the biomass associated with B_{MSY} (see Section 4.1.2). The condition of the white marlin under both the total and north Atlantic stock scenarios has continued to degenerate to historically low levels (Figures 4.1.2 and 4.1.4). Sailfish resources in the Atlantic are near or below the level associated with B_{MSY} (Figure 4.7.5); however, any expansion of foreign longlining effort could further reduce the availability of these billfish resources to U.S. fishermen. Recent quota reductions for directed species such as swordfish, bigeye tuna, southern albacore, and bluefin tuna may result in lower longline effort and perhaps reductions in billfish bycatch by that fleet. Continued efforts to promote sustainable fisheries at the international level are a critical component of Atlantic billfish management.

All member countries of ICCAT must begin to reduce blue marlin and white marlin landings by at least 25 percent beginning in 1998, to be completed by the end of 1999, to be in compliance with the 1997 ICCAT recommendation. This is the first action by ICCAT to reduce landings of billfish in the Atlantic Ocean, and is just a first step in rebuilding these over-exploited stocks.

Figure 4.7.1. Reported catches of Atlantic Blue Marlin from the Atlantic Ocean (North and South Atlantic Ocean combined) for 1987 to 1996 (SCRS 1997).

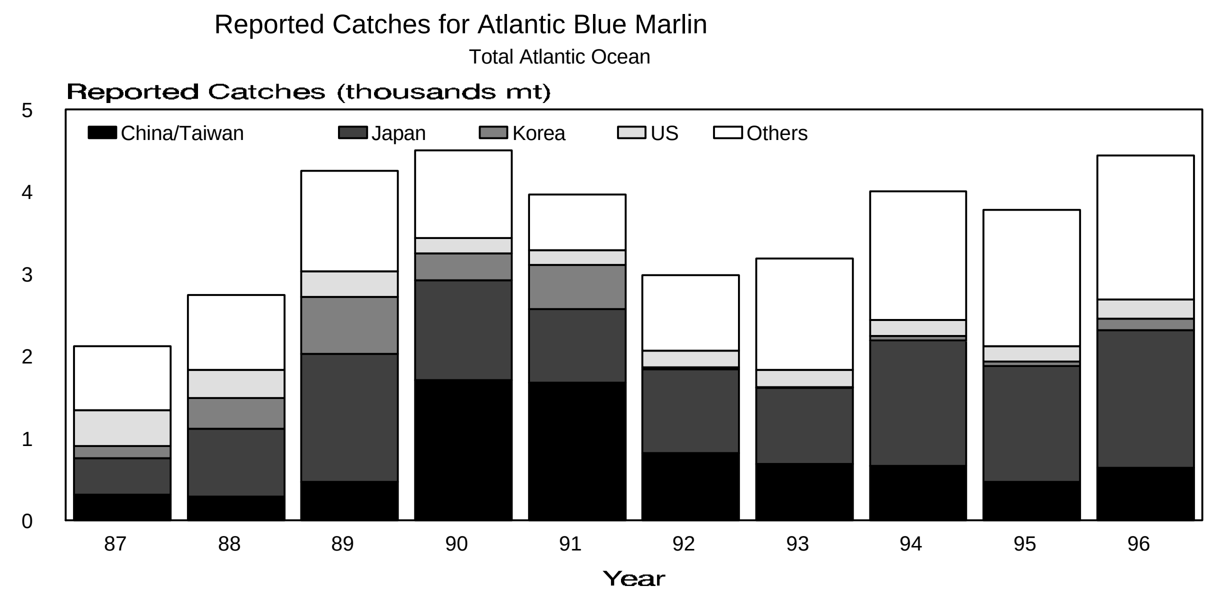

Figure 4.7.2 Reported catches of Atlantic White Marlin from the Atlantic Ocean (North and South Atlantic Ocean combined) for 1987 to 1996 (SCRS 1997).

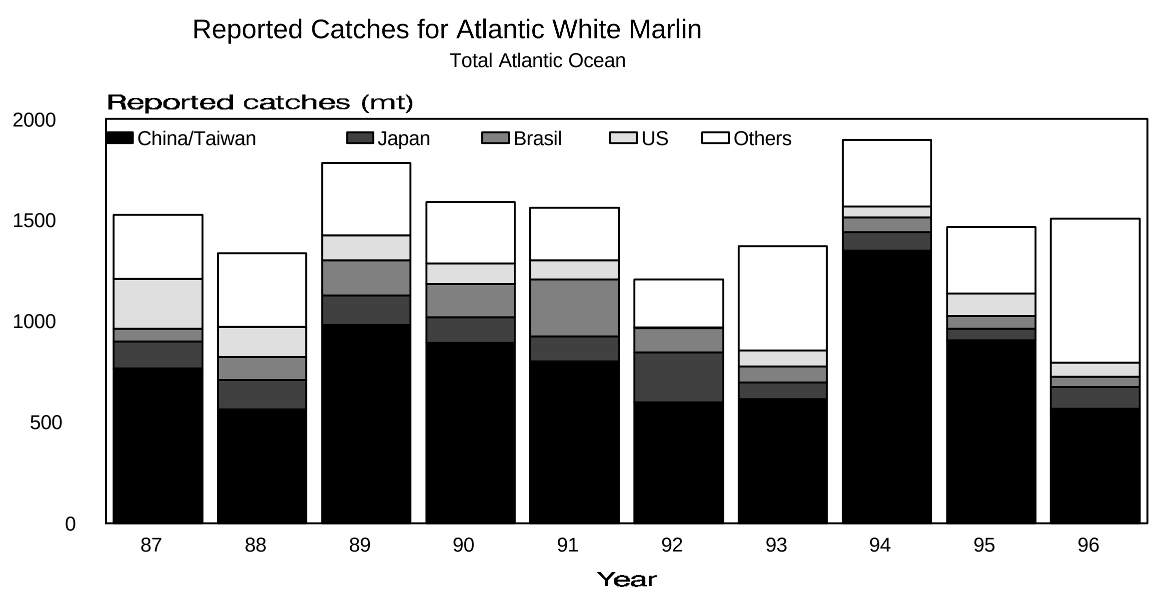

Figure 4.7.3. Reported landings (in mt) of Atlantic sailfish and spearfish, by year and country, for the western Atlantic Ocean (SCRS 1997).

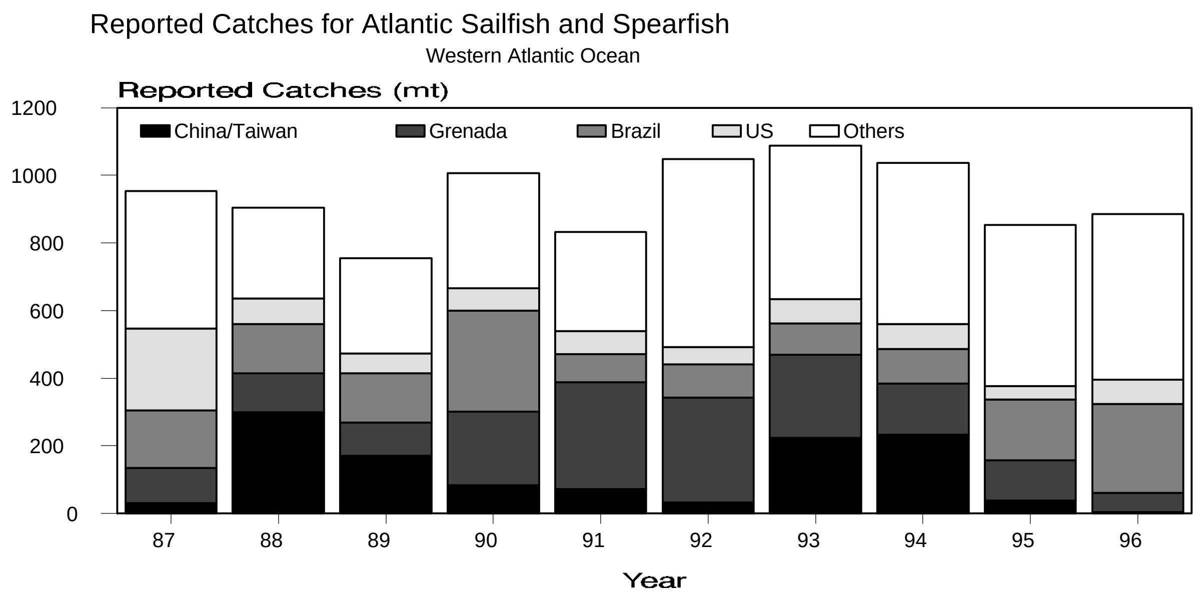

Figure 4.7.4. Reporting landings of blue marlin in the north, south and total Atlantic Ocean (data from SCRS/97/19)

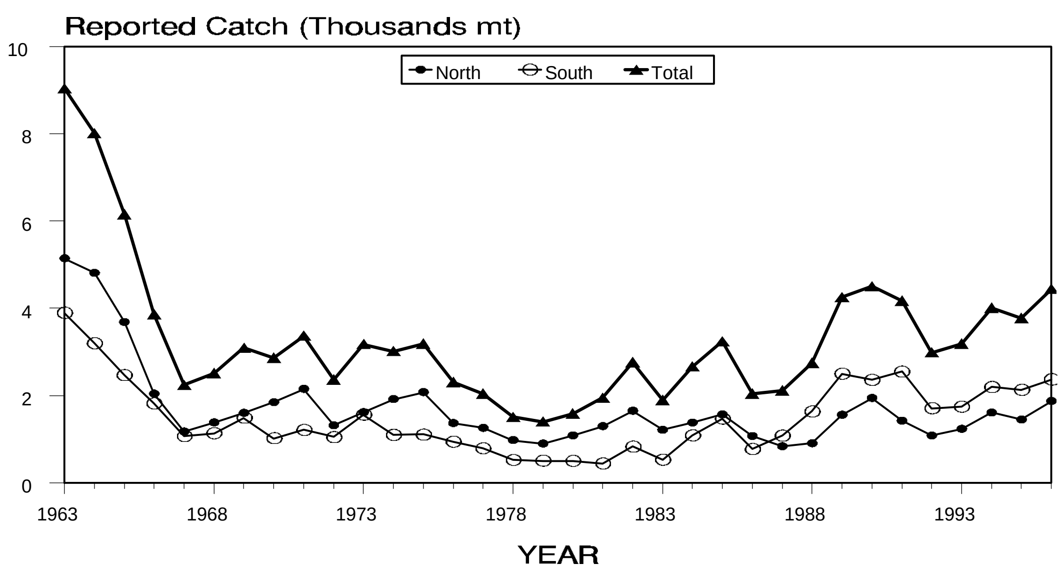

Figure 4.7.5. Reporting landings of white marlin in the north, south and total Atlantic Ocean (data from SCRS/97/19).

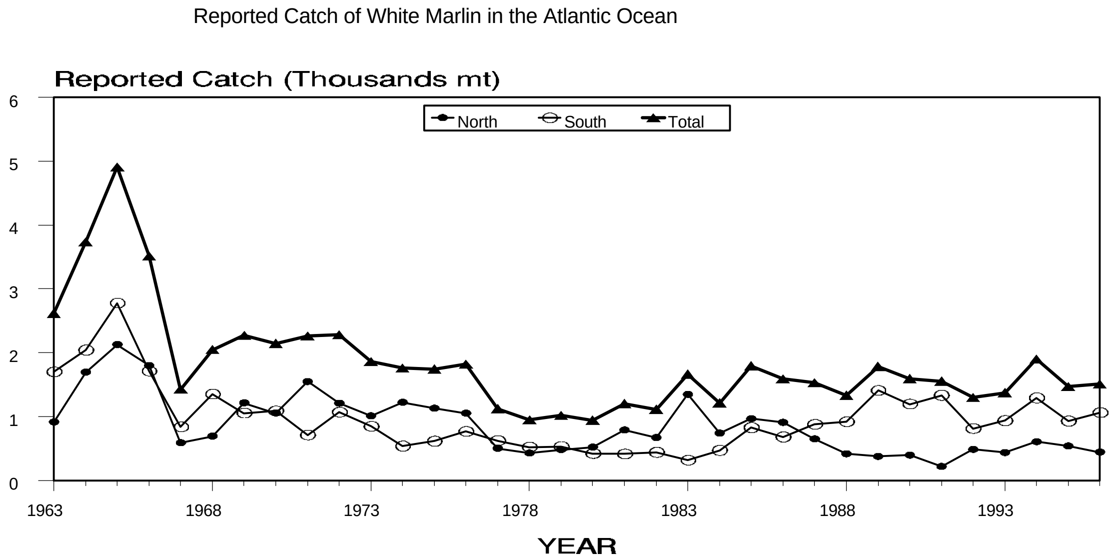

Figure 4.7.6. Reporting landings of sailfish and spearfish in the east, west and total Atlantic Ocean (data from SCRS/97/19).

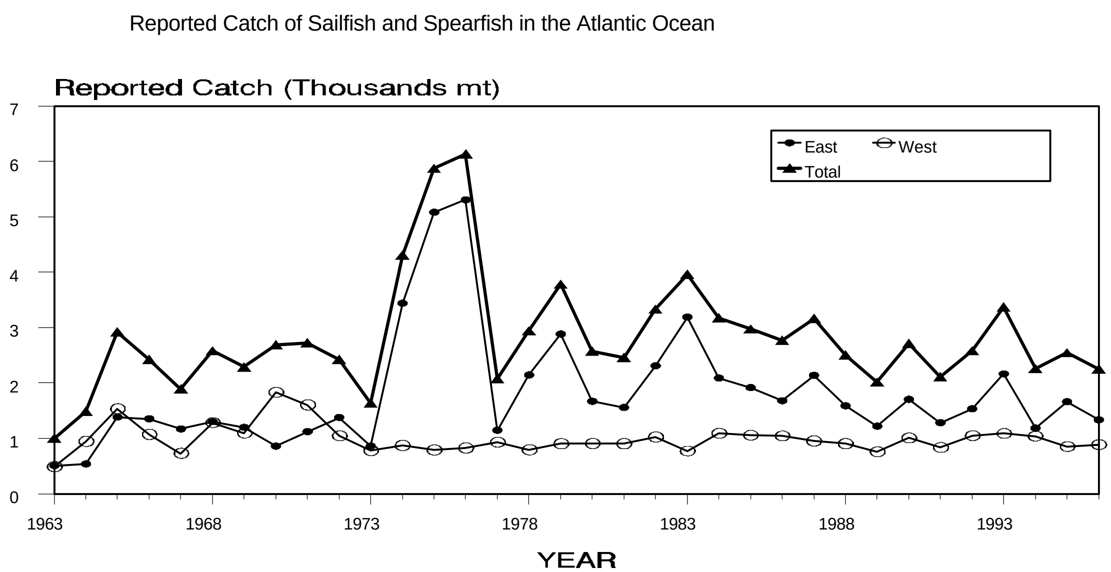

Figure 4.7.7. Summary of number of Atlantic billfish discarded by U.S. fishermen, by area and year, from longline gear, based on pelagic logbook data (Cramer and Scott 1998).

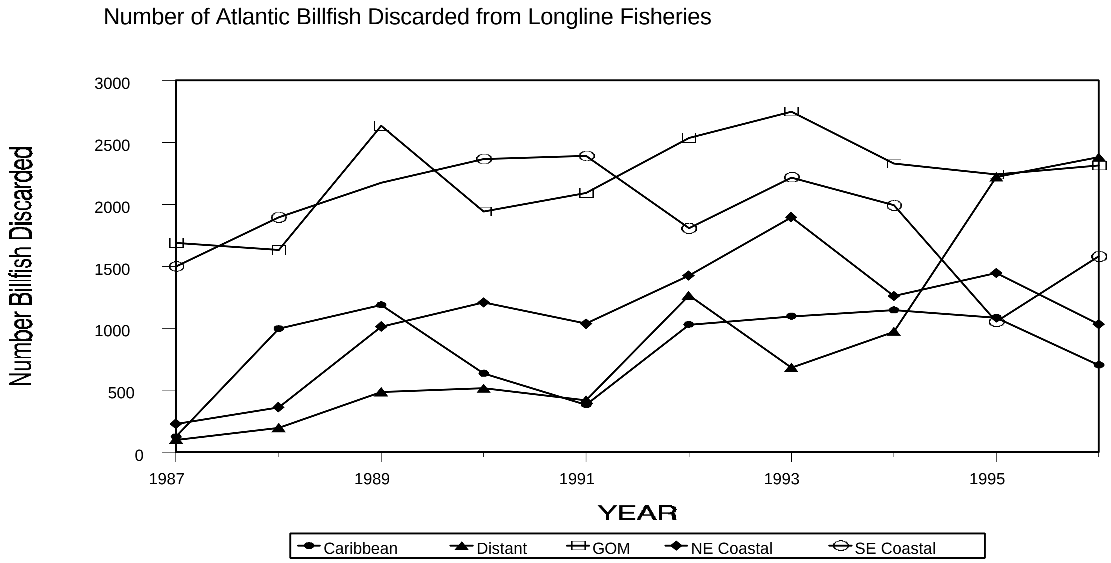

Figure 4.7.8. Landings of Atlantic blue marlin in the United States (data from SCRS/96/19.

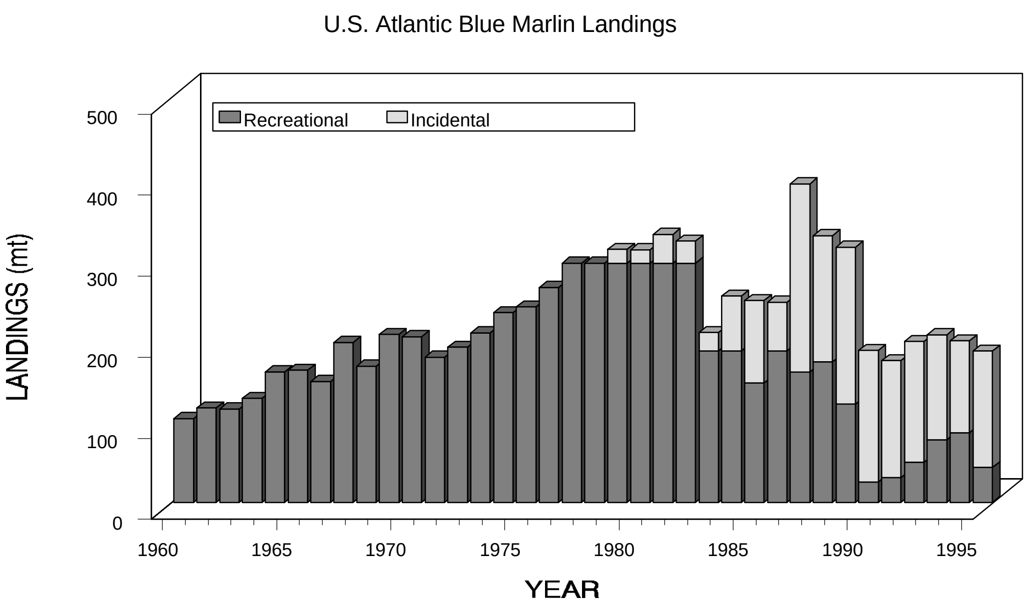

Figure 4.7.9. Landings of Atlantic white marlin in the United States (data from SCRS/96/19).

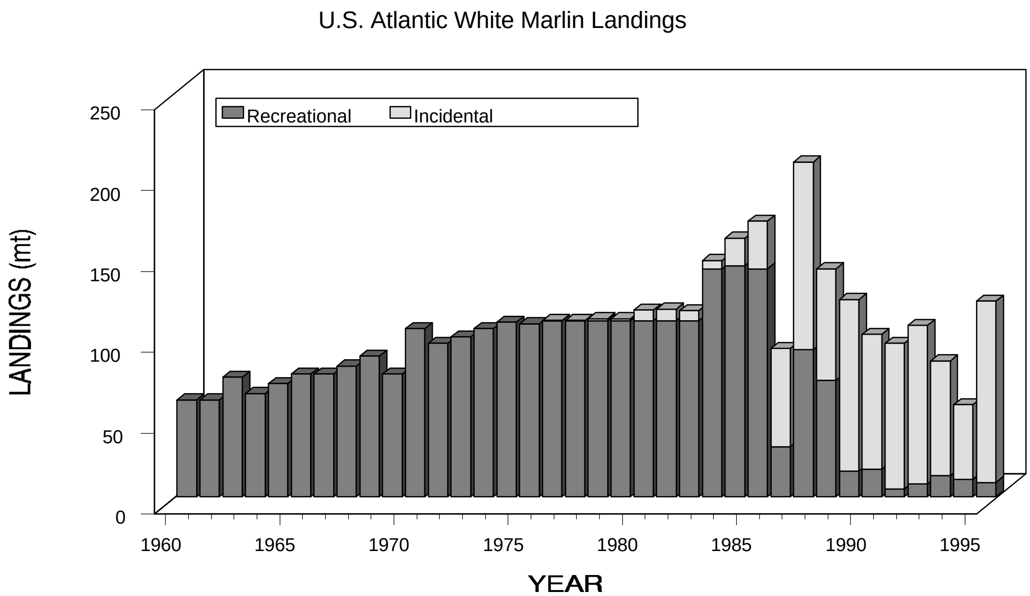

Figure 4.7.10. Composited relative indices of north Atlantic white marlin from rod and reel gear (data from SCRS/96/19).

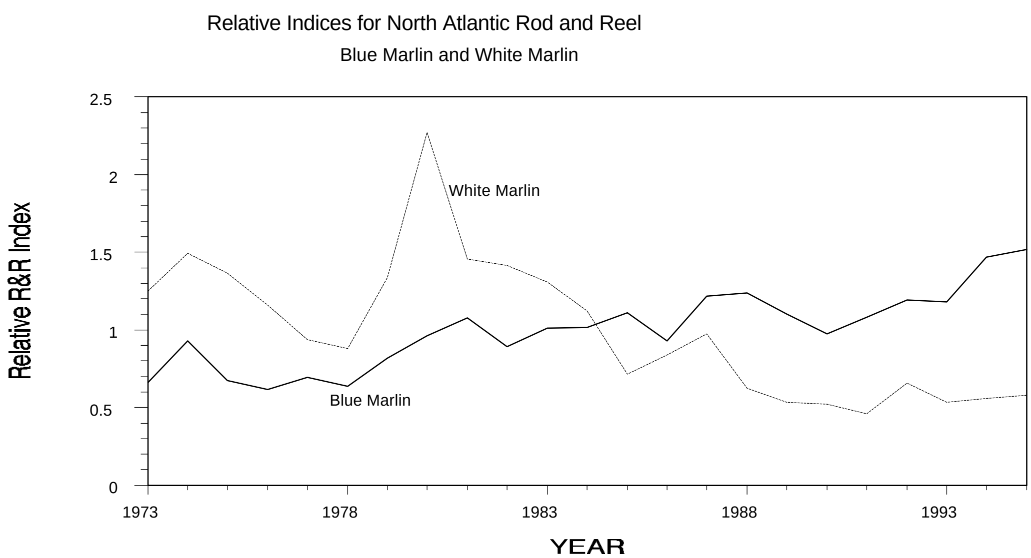

Table 4.7.1. Number of Atlantic billfish caught and percent released alive, by area, from the 1995 U.S. commercial longline fishery.

Location	Number Blue Marlin Caught	Percent Blue Marlin Released Alive	Number White Marlin Caught	Percent White Marlin Released Alive	Number Sailfish Caught	Percent Sailfish Released Alive	Number Spearfish Caught	Percent Spearfish Released Alive
Caribbean	538	84.5	183	77.8	52	73.2	22	100
Grand Banks	11	64	19	73.8	0	N/A	21	66.5
Gulf of Mexico	411	69.6	434	63.9	504	56	11	27
Northeast Coastal	160	79.6	808	71.6	17	70.4	2	50
Offshore South	869	69.2	588	61.1	129	41.9	270	62.3
Southeast Coastal	308	75.6	258	78.7	258	66	24	79.2
Total	2297	74.4	2290	68.8	960	58	350	64.9

Table 4.7.2 Regional billfish catch and harvest characteristics for the 1989 recreational billfish tournament anglers (Fisher and Ditton 1990).

Region	Number of Respondents	Total Billfish Boated	Total Billfish Retained	Percent Released	Catch per Angler	Retention per Angler
Caribbean	100	184	48	74	1.84	0.48
Gulf of Mexico	326	270	50	81	0.83	0.15
Mid-Atlantic	318	687	34	95	2.16	0.11
South Atlantic	343	583	51	91	1.7	0.15
Total	1129	1821	196	89	1.61	0.17

Table 4.7.3. Summary of ICCAT member countries with the highest reported catches (mt) of billfish, by species, for 1996.

COUNTRY	North Atlantic Blue Marlin mt (%)	South Atlantic Blue Marlin mt (%)
Brazil	0	82(3.5%)
Chinese Taipei	257(13.7%)	386(16.3%)
Cote d'Ivoire	0	144(6.1%)
Ghana	0	422(17.9%)
Japan	794(42.4%)	874(36.9%)
Korea	41(2.2%)	103(4.3%)
Trinidad & Tobago	150(8%)	0
U.S.	232(12.4%)	1(0.04%)
Venezuela	113(6%)	0
All Other Countries	283(15.1%)	357(15.1%)
Total (All Countries)	1870	2369

COUNTRY	North Atlantic White Marlin mt (%)	South Atlantic White Marlin mt (%)
Brazil	0	51(4.8%)
Chinese Taipei	113(25.5%)	453(42.5%)
Gabon	0	406(38.1%)
Japan	81(18.3%)	28(2.6%)
Korea	7(1.6%)	50(4.7%)
NEI-1	50(11.3%)	52(4.9%)
U.S.	70(15.8%)	0
Venezuela	96(21.7%)	0
Other Countries	33(7.4%)	25(2.3%)
Total (All Countries)	443	1065

COUNTRY	West Atlantic Sailfish mt	% OF TOTAL CATCH
Brazil	263	29.7%
Dominican Rep.	90	10.2%
Trinidad & Tobago	100	11.3%
U.S.	72	8.1%
Venezuela	148	16.7%
Other Countries	213	24%
Total (All Countries)	886	100%

4.8 Description of Economic Characteristics

Since 1988, the economic benefit of the Atlantic billfish fishery in the United States has stemmed solely from the recreational fishery, since 1988 Atlantic Billfish FMP prohibited sale of Atlantic billfish from its management unit. However, as pointed out by Ditton (1994), the economic value of the recreational billfish fishery was not adequately established in the FMP. The number of billfish anglers is relatively small in comparison to other angler groups, and is generally characterized as a “rare event” fishery, both in terms of the number of participants and the number of fish caught and/or landed (Fedler and Ditton 1990). This section provides a general description of the economics of the billfish fishery.

There are two types of economic statistics that are used in evaluating the economic importance of a fishery, and it is important to be able to distinguish between the two types, to avoid abuse of the term "economic importance." The first type of statistic is economic impact, which often interests both commercial and recreational fishermen, referring to the money generated by their activity. In the commercial fishery, economic impact may include expenditures (bait, tackle, labor, etc.) and/or ex-vessel value of landings, plus value added in processing and distribution. In the recreational fishery, economic impact includes the money spent by anglers, such as charter boat fees, bait, fuel and tackle, travel (lodging, gas, hotels, restaurants, etc.). Conservationists may refer to the economic activity generated by non-consumptive uses of a resource (e.g. whale watching).

The second type of statistic is net economic benefit, which is the sum of producer and consumer surplus associated with the fishery. In the commercial fishery, economic benefit is profits, that is, the difference between total revenues and total costs. For species that are consumed domestically, the consumer surplus must also be added to profits. For the recreational fishery, net economic benefit is the sum of charter/party vessel profits plus angler consumer surplus. The angler consumer surplus essentially measures the additional amount that an angler is willing to pay for the experience of catching and/or landing a fish, over and above what the angler currently pays. Angler consumer surplus is not a measure of the costs associated with fishing such, as gear, fuel, food, and charter costs. Instead, it measures what the angler is willing to pay for the fishing experience beyond the costs associated with the trip, perhaps better described as a way of placing a monetary value on the pleasure that anglers get from participating in their fisheries. Conservationists who place a value on the survival of a species also "benefit" from the fishery; sometimes this is referred to as "existence value," a different kind of consumer surplus.

In previous management of Atlantic billfish, the focus was on anglers’ expenditures (i.e, the first type of economic measures discussed above) as a measure of the economic effect of the recreational fishery (Ditton 1994); the economic value of the recreational Atlantic billfish fishery was not previously considered. The net economic value of a recreational activity is measured in terms of the net value of the activity to the participants over and above costs, which is its value to the nation. Economic impact is not same as the economic value, because if recreationists cannot spend their money on a particular recreational activity, that money will be spent in another sector of the national economy. However, in the case of forgone recreational fishing activity, while the nation as a whole might not suffer economic loss, the coastal communities and businesses frequented by saltwater anglers may be negatively impacted by decreased fishing activity. Billfish fishing is generally favored by persons with personal incomes that are far above the average U.S. per capita income (Ditton 1996), which means that these anglers can afford to take their fishing activities to other countries, potentially decreasing the benefit of saltwater angling to the United States.

Adequate data and analyses for these types of economic measures are rare. However economic studies have been conducted on the U.S. recreational billfish fishery. Estimates of angler consumer surplus, as well as economic impact for the recreational sector associated with billfish tournaments were generated using contingent valuation methods for U.S. Atlantic coast by Fisher and Ditton (1992), and Puerto Rico by Ditton and Clark (1994). Other studies have provided similar information for charter boat billfish anglers in Costa Rica (Ditton and Grimes 1995) and in Southern Baja, Mexico (Ditton et al. 1996).

Fisher and Ditton (1992) completed an inventory of 359 billfish tournaments held in 1989 along the U.S. Atlantic coast, including the Gulf of Mexico (except Connecticut, Mississippi and New Hampshire), as well as Puerto Rico and the U.S. Virgin Islands. A total of 1,984 billfish anglers were surveyed, with 1,171 anglers responding. Respondents reported spending an average of $1,601 (excluding tournament fees) for a billfish fishing trip (Table 4.8.1) that lasted an average of 2.59 days, with an average of 13 trips taken each year. The average amount spent annually on billfish tournament fees was $1,856, or $546 per tournament, giving a $2,147 total expenditure per angler per trip. The total annual expenditure estimates generated from the Fisher and Ditton study indicated that in 1989, billfish tournament anglers spent an estimated $180 million in attempting to catch billfish (tournament and non-tournament trips), giving an average equivalent expenditure of $4,242 for each fish caught or $32,381 for each billfish landed. Ditton (1996) reported that the annual net economic benefits for the group surveyed was over $2 million. Fisher and Ditton estimated that there were 7,915 U.S. tournament billfish anglers, which translates to a $262 annual consumer's surplus per billfish angler.

Ditton and Clark (1994) provided a description of the economics associated with recreational billfish anglers participating in at least one of 14 billfish tournaments held between August, 1991 and October, 1992 in Puerto Rico. A total of 885 residents (of an estimated 1,475 resident billfish participants) and 154 non-resident anglers (82 were from the mainland United States or U.S. Virgin Islands; 72 were from other countries) were surveyed. Trip expenditures per resident averaged $711 per trip (average of 21 trips/year) and $3,945 for non-resident anglers fishing in Puerto Rico (average 7 billfish trips in Puerto Rico). Resident angler expenditures averaged $1,963 per billfish caught, while expenditures for non-residents averaged $2,132 per billfish caught. Ditton and Clark (1994) estimated the net economic benefits per trip at $549, yielding total annual net economic benefits of $18 million. Total resident and non-resident (U.S. citizens and foreign countries) angling expenditures were over $21 million and $4 million, respectively.

Regarding the commercial fishery, the critical values for the billfish fishery are the forgone gross revenues (and/or consumption) resulting from the ban on retention of billfish bycatch. Atlantic billfish caught by U.S. commercial fishing operations (mainly swordfish and tuna longline fisheries) in the Atlantic Ocean (including the Gulf of Mexico and Caribbean Sea) can not be landed or sold. In the Pacific Ocean, however, billfish can be landed and sold by U.S.-flagged vessels and marketed in states other than their state of origin, provided that proper documentation accompanies the sale of the fish as described in 50 CFR 644.24. Using ex-vessel price information from the Hawaii longline fishery (Ito and Machado 1997), a calculation can be made of the gross revenues forgone by U.S. commercial fishermen for discarding the incidental catch of billfish in the Atlantic Ocean (Table 4.8.2). During 1989 to 1996, the value of billfish discarded by longline fishers ranged from $237,989 to $433,207 for Atlantic blue marlin, with an eight-year total value (1989 to 1996) of $2.5 million. Estimated value of Atlantic white marlin over this same time period totaled $1.6 million, with annual values ranging from $149,189 to $254,633 (using striped marlin ex-vessel prices as an approximation of white marlin prices). Gross revenues forgone from sailfish dead discards from pelagic longline gear between 1989 to 1996 ranged from $123,194 to $198,667, with a total value over eight years of $1,118,950. Over the eight-year period between 1989 and 1996, the total estimate of gross revenues foregone for dead discards of all billfish (blue marlin, white marlin and sailfish) is $5.3 million, or $664,648/year. Whiles these values are far from insignificant, they are considerably less than the $180 million spent each year by tournament anglers alone, and net economic benefits of $2 million per year.

Fishing capacity reduction program

Under the Magnuson-Stevens Act, another potential management tool is a vessel or permit "buyback" program. Buyback programs pay vessel owners to surrender fishing permits and/or withdraw vessels from fishing. This may reduce excess capacity, increase harvesting productivity, and help conserve and manage fisheries. This type of management tool can only be implemented if: 1) the program is shown necessary to prevent or end overfishing, rebuild fish stocks, or achieve significant improvements in the conservation and management of the fishery; 2) there is a fishery management plan that prevents the replacement of fishing capacity removed by the program and establishes a specified or target TAC which triggers closure of the fishery; and 3) the program is cost-effective. Under this type of program vessel owners would be paid to either: 1) surrender their fishing permits and relinquish any claim associated with the fishing permit; or, 2) surrender their fishing permits, withdraw their vessels from fishing, and relinquish any claims associated with the fishing permits and/or vessel. NMFS may consider this option after the rebuilding program proposed in this FMP, including limited access, is established.

The buyback program may be financed in a number of ways. The standard option is to have NMFS borrow funds from the U.S. Treasury under Title XI of the Merchant Marine Act. These funds would then be used to purchase vessels, and those vessels remaining in the fleet (who reap the benefit of a less-crowded fishery) would repay this “statutory loan” through a landing fee (maximum five percent) on the value of ex-vessel landings of the species for the fishery or fisheries in question. Following discussions by the billfish AP, NMFS has deemed that it would also be possible for recreational resource users to design a buyback program funded (fully or partially) by recreational constituents. This program design would be submitted to an appropriate requesting authority and the FMP would be amended as necessary to accommodate this plan. NMFS is exploring options for making such a recreationally-funded program possible through framework provisions in the FMP and FMP Amendment.

Table 4.8.1 Mean expenditures per trip by billfish tournament anglers (from Fisher and Ditton 1992).

Expenditure Item	Mean Spent per Angler	Percent of Anglers Who Bought Item	Mean Expense to Angler Purchasing Each Item
Food, drinks, ice	$152.61	80.2	$190.29
Boat operation	$462.56	72.8	$635.38
Bait and tackle	$95.65	67.1	$142.55
Automobile transportation	$38.28	58.7	$65.23
Lodging	$163.88	32.9	$498.12
Non-automobile transportation	$170.64	25.2	$677.14
Captain/charter fees	$203.75	23.8	$856.09
Slip rental, repairs, satellite data, etc	$90.28	14.1	$640.28
Boat rental	$144.23	10.5	$1,373.62
Entrance fees	$50.57	10.1	$500.69
Boat launch/hoist fees	$28.16	8.9	$316.14
Total (N=1,129)	$1,600.62		

Table 4.8.2. Longline dead discards of Atlantic Blue Marlin, Atlantic White Marlin, and Sailfish for 1989 to 1996 (Cramer 1998) and calculation of income forgone based on prices from the Hawaii longline fishery.

Species	Year	Longline Discards in mt	Longline Discards in lbs	Ex-vessel prices	Estimated Income Foregone
Blue Marlin					
	1989	191	421,082	$0.84	$353,709.00
	1990	159	350,534	$0.92	$322,492.00
	1991	142	313,056	$0.78	$244,184.00
	1992	147	324,079	$1.16	$375,932.00
	1993	127	279,987	$0.85	$237,989.00
	1994	112.9	248,902	$1.28	$318,594.00
	1995	143.8	317,024	$0.87	$275,811.00

Species	Year	Longline Discards in mt	Longline Discards in lbs	Ex-vessel prices	Estimated Income Foregone
	1996	196.5	433,207	$1.00	$433,207.00
	Total				$2,561,918.00
White Marlin[3]					
	1989	105	231,485	$1.10	$254,633.00
	1990	82	180,779	$1.38	$249,474.00
	1991	89.3	196,873	$0.99	$194,903.00
	1992	88	194,007	$1.27	$246,388.00
	1993	65.7	144,844	$1.03	$149,189.00
	1994	42.4	93,476	$1.70	$158,909.00
	1995	99.8	220,021	$0.90	$198,019.00
	1996	67.6	149,032	$1.24	$184,800.00
	Total				$1,636,315.00
Sailfish					
	1989	56.9	125,443	$1.10	$137,987.00
	1990	65.3	143,962	$1.38	$198,667.00
	1991	67.3	148,371	$0.99	$146,887.00
	1992	44	97,003	$1.27	$123,194.00
	1993	66.1	145,725	$1.03	$150,097.00
	1994	29.2	64,375	$1.70	$109,437.00
	1995	28.7	63,273	$0.90	$56,946.00
	1996	71.6	157,851	$1.24	$195,735.00
	Total				$1,118,950.00

[3]Price information for Atlantic white marlin is based on ex-vessel price of striped marlin from Hawaii's longline fishery.

4.9 Description of Social and Cultural Framework

4.9.1 Overview

As part of the social and cultural impact assessment of the Fisheries Management Plan (FMP) for Highly Migratory Species and the current amendment to the FMP for Atlantic Billfish, an analysis was conducted by the Ecopolicy Center for Agriculture, Environmental and Resource Issues at Rutgers, the State University of New Jersey, under contract numbers 40AANF801251 and 40AANF804218 with the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS). A social and cultural impact assessment is required in the development of the FMPs and FMP amendments:

1. Information on distributional impacts, non-quantifiable considerations such as expectations and perceptions of the alternative actions, and the potential impacts of the alternatives on both small economic entities and broader communities;

2. Descriptions of the ethnic character, family structure, and community organization of affected communities;

3. Descriptions of the demographic characteristics of the fisheries;

4. Descriptions of important organizations and businesses associated with the fisheries; and

5. Identification of possible mitigating measures to reduce negative impacts of management actions on communities.

6. Information on distributional impacts, non-quantifiable considerations such as expectations and perceptions of the alternative actions, and the potential impacts of the alternatives on both small economic entities and broader communities;

7. Descriptions of the ethnic character, family structure, and community organization of affected communities;

8. Descriptions of the demographic characteristics of the fisheries;

9. Descriptions of important organizations and businesses associated with the fisheries; and

10. Identification of possible mitigating measures to reduce negative impacts of management actions on communities.

NMFS (1994) guidelines to be used in social impact assessments were followed. These guidelines require identifying baseline conditions, scoping the full range of potential impacts from each proposed alternative, projecting estimated effects from these impacts, and predicting the significance of potential responses to these impacts. Baseline data include population data, household and educational characteristics, community and institutional structures, political and social resources, and attitude variables such as views of the fishery. The NMFS guidelines were primarily designed for assessing impacts on single, well defined fishing communities. The study conducted by the Ecopolicy Center for Agriculture, Environmental and Resource Issues however, covers four species groups (tuna, swordfish, shark and billfish) which have important commercial and recreational fisheries extending from Maine to Texas and the Caribbean. Reasonable limits on time and funds precluded any attempt to cover all the affected fishing communities.

The study focused on these impacts in five states: Massachusetts, New Jersey, North Carolina, Florida, Louisiana, and in Puerto Rico. These states were chosen for study partly because they each had important fisheries that would be impacted by the HMS FMP and Atlantic Billfish FMP Amendment, and because they are fairly evenly spread around the eastern U.S. Atlantic coast. For each state, a profile of basic sociological information was compiled, with at least two coastal communities visited for further analysis (see Appendix G). Communities were selected partly based on landings data, but they were not necessarily the biggest or most important ports in terms of economic value. Additional criteria included the relationship between the communities and the fishing fleets. The guidelines for National Standard 8 of the Magnuson-Stevens Act define a community as a "social or economic group whose members reside in a specific location and share a common dependency on commercial, recreational or subsistence fishing or on directly related fisheries-dependent services and industries." While this definition defines a fishing community as a geographical location, FMPs have their most direct impacts on fishing fleets that use specific gears. The relationship between these fleets and fishing communities is not always a direct one. Indeed, this relationship is an important variable for understanding social and cultural impacts. A second factor influencing the selection of these communities was the existence of other community studies. Finally, the Advisory Panels for HMS and Billfish provided extensive input on which fishing communities should be included in this analysis.

Regulatory impacts on these communities were traced through seven affected fisheries by obtaining qualitative information on the social impact of various management alternatives. The seven affected fisheries included in the study were the pelagic longline fishery, bluefin tuna purse seine fishery, drift gillnet swordfish fishery, recreational bluefin tuna fishery, recreational shark fishery, recreational billfish fishery, and the Puerto Rican deep water artisanal fishery. Only information on the recreational billfish fishery and the Puerto Rican deep water artisanal fishery is included in this Amendment to the Billfish FMP. Communities selected for the study where recreational billfish fishing plays an important role in the community included: Venice LA, Panama City FL, Madeira Beach FL, Islamorada FL, Pompano Beach FL, Arecibo PR, and Hatteras, NC. Communities included in the study for the deep water artisanal fishery were Anguadilla, PR, and Acrecibo, PR.

In each of these communities, researchers conducted “key informant interviews,” and sometimes group interviews, with fishers, fishing crew, processors, leaders of fishing organizations, and suppliers. A total of 139 key informant interviews were conducted with either one or two people and five group interviews with more than two people. Constraints on time and money precluded a more complex statistical design, but even the most complete research design would have used the same types of interviews. Key informant interviews are guided discussions in which the interviewer moves the interview from topic to topic. The interviewer asks many specific questions as issues arise, but also tries to allow the respondent to shape the terms in which the issues are framed. This line of questioning helps reveal not just the respondent's perceptions of what is happening, but the meaning which the respondent attaches to these perceptions.

Qualitative interviews such as these are valuable in determining people's perceptions, but are less precise than formal, quantitative surveys. Evaluating the accuracy of the responses is done by what social scientists call “triangulation.” If several people give different stories about the same issue, the researchers then either do not report anything, or report that people disagree. If several people who are all in the same fishing sector make a similar statement, especially when the interviewer does nothing to lead the statement with a question, then researchers consider this an accurate reflection of how that part of the industry sees the issue. If there is confirmation from someone who does not share that groups’ economic interest in the fishery, that provides additional evidence of what is going on in the community. Results are further confirmed when researchers hear the same story in community after community from people in different parts of the industry. All of these interviews took place under Rutgers University rules for “human subjects research.” This means that the responses are confidential. No person or business is identified or quoted by name.

Fishing regulations affect fishing operations in many different ways. Researchers identified three categories of impacts on operations. First, fishing regulations can affect the *volume* of money that is going through the community. In commercial operations this is a function of the amount and price of fish. In recreational operations this is a function of the amount people are willing to pay for a fishing experience. Second, regulations can affect the *flexibility* of fishing operations. This is the ability of the operation to change in response to changes in the resource, the market, or their customer base. Often regulations affect the ability of fishing operations to make plans. Many systems of regulations indirectly create uncertainties for the fishing operations that make business planning more difficult. This often has more to do with how the regulation is administered than the regulation itself. Finally, regulations can impose *direct costs* on fishing operations by requiring them to buy something or to pay someone to do something. These impacts on operations, in turn, create impacts in the broader community. Impacts on employment and overall wealth are very important, as are changes in a community's identity as a fishing community, and its perspective on the future of fishing-related activities. Social relationships such as the role of kinship and the aggressiveness of competition also affect the quality of life in the community.

Researchers used these three categories to organize the proposed alternatives into manageable units. Quotas, size limits, and bycatch limits are considered under “Volume” impacts, although the report differentiates between the quotas themselves and the derby-style organization of quota systems. Time and area closures, controls on soak time, prohibitions, and other gear restrictions are considered under "Flexibility." VMS, permits, reporting, and industry-financed observers are considered under "Direct Costs."

The magnitude and importance of any impact is also a function of the characteristics of the fishing community. The first community characteristic is the existence of alternative activities, both fishing and non-fishing. The more alternatives available to someone who must change their behavior because of a regulation, the better that person is able to deal with the change. The second is economic vulnerability. This is the amount and sources of pressure and competition those in fishing related businesses face in getting the things they need to run their operations and in selling their products. The more vulnerable the fish-related operation is, the greater the impact of a regulation on the lives of the people related to that operation. The third is community support. Communities differ in the degree to which social capital, i.e., networks of people able to lend aid, is available to people and fishing operations affected by regulations. The more community support, the better the communities can absorb the impact of the regulation. Information included in the report summarizes the views and opinions of survey individual and groups, and must be evaluated in terms of the survey design and sample size relative to the operational scope of the recreational billfish fishery.

4.9.2 Social and Cultural Impact Assessment

Based, in part, on a study entitled "Social and Cultural Impact Assessment of the Highly Migratory Species Management Plan and the Amendment to the Atlantic Billfish Management Plan," state and community profiles for the Atlantic Billfish fishery and for the Puerto Rican artisanal fishery are included as Appendix G. For each fishery component, three community-level factors are described: alternatives, economic vulnerability, and community support. Specific measures that researchers deemed would have important impacts on the volume of product, the flexibility of fishing-related operations, and on the direct costs of regulation are then evaluated. The analysis of each fishery component concludes with a short discussion of the expected overall impact of increased fishing restrictions on both participants in the industry and the community as a whole. The summaries also includes comments on various potential management measures from individuals interviewed as part of this study.

4.9.2.1 Recreational Billfish Fishing Communities

Researchers found recreational billfish fishing to play an important role in the communities of Venice LA, Panama City FL, Madeira Beach FL, Islamorada FL, Pompano Beach FL, Arecibo PR, and Hatteras NC. The adventure of fishing for billfish attracts fishers and their families to these communities. An expensive fishery with expensive gears, the recreational angling for billfish often attracts wealthier customers than inshore fisheries. Researchers noted that billfish tournaments were important, not just as revenue generators for both business and charity, but as community social events. In general, recreational fishers are very passionate about, and committed to, billfish fishing. Researches noted that there are no alternative fisheries that can play the same role that billfish plays in the recreational community.

According to the study, the dependence of these communities on billfish is related in a complex way to the number of billfish available to be caught. The few billfish anglers awarded prizes at a tournament can be indirectly worth hundreds of thousands of dollars to the community. Study researchers stress the importance of the expectation in the customer's mind that there is a chance of catching a fish. In the case of marlins, the possibility of catching the fish is so attractive that customers will buy the fishing experience with a comparatively low expectation of catching the fish. This is not to say that having more fish available to the community is not better than less fish, especially since the community is competing with other billfish fishing destinations for customers. The study does explain however, that a community may continue to benefit from the fishery, despite a relatively small billfish stock size. In the Florida communities, the local billfish anglers, as opposed to tourist anglers, are generally very committed anglers who spend a great deal of money in the pursuit of billfish angling. The recreational fishing sectors in the targeted communities are large and tournaments and other community events create a community feeling among participants. Except for Hatteras, none of these ports are integrated fishing communities where the commercial and recreational components see themselves as part of the same social network. In Florida and Louisiana the recreational and commercial groups tend to be hostile to one another and interact rarely.

Most of the management measures discussed in the surveys were found to be less conservative than existing fishing behavior, and therefore will likely have no negative impacts on these communities. Recovery of the stock would have the important positive impact of allowing U.S. billfishing destinations to compete with foreign billfishing destinations. Increased recreational permitting and mandatory record keeping were one set of measures that receive similar responses from recreational fishers throughout the study. The reaction from study respondents regarding increased record keeping and reporting as a nuisance, with some fishers more willing to put up with the nuisance than others. Several fishers expressed distrust of fisheries managers to use the data correctly. Several others say that they wanted to see an account of how permit money would be used before they would be willing to pay for increased permitting. However, researchers found neither the nuisance factors, the costs of the permits relative to other costs of offshore billfish and highly migratory species fishing, nor the questions about the legitimacy of these measures rose to the level of a community impact.

In a separate study, Ditton (1996) described typical participants in billfish angling as white males in their forties, highly educated, with high annual household incomes (Table 4.9.1). The participation characteristics of these individuals indicate that billfish anglers have many years of experience in both saltwater angling and fishing for billfish. Ditton (1996) indicated that billfish anglers tend to fish twice as frequently as those targeting other saltwater species. These results are similar to those found by Maiolo (1990) from a survey of U.S. billfish anglers participating in tournaments along the east coast, Gulf of Mexico and Caribbean (Puerto Rico and Bahamas).

4.9.2.2 The Puerto Rican Deep Water Artisanal Fishery

Study researchers found the artisanal fishery on the northwest coast of Puerto Rico targeted mainly tuna and mahi-mahi (dolphin fish), therefore billfish (generally taken as bycatch to directed fishing efforts) does not play a significant role in the overall economy of these communities. These are small scale fishers selling their fish to individuals and local kiosks. Even local restaurants mainly use fish trucked in to the communities. These are very poor fishers living in communities with very high unemployment, illiteracy, and numbers of public assistance recipients. Fishing is their livelihood, with public assistance being a likely second option. They receive assistance from the government in the form of facilities to clean and sell their fish.

Seafood plays an important cultural role in these communities but the artisanal fishery is not integrated into the rest of the economy. In fact, respondents noted considerable friction between the artisanal fishers and tourist-oriented seaside development. The fishers are organized into government sponsored fisheries development organizations that are administered by a different department than the one responsible for fisheries management.

4.9.2.3 National Standard 8 - Communities

Under NSG 8, conservation and management measures "shall, consistent with the conservation measures of the Magnuson-Stevens Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to:

1. Provide for the sustained participation of such communities; and
2. To the extent practicable, minimize adverse economic impacts on such communities."

It is not anticipated that any of the proposed management measures included in the draft FMP Amendment will have a significant impact on affected communities.

4.9.3 Fishing Organizations

There are an array of associations for fishermen, most often based on gear type. Most of these organizations have a designated lobbyist in management fora. The organizations with higher membership are more apt to have paid staff who can represent them at meetings, and consequently, have had a more active voice in the development of the fishery management plan. In developing the Billfish AP, NMFS sought to appoint not just lobbyists for these groups but representatives of other sectors of the fishing industry including tackle distributors,, state management agencies, etc.

However, it is common felt by active fishermen that they are not well represented. The numbers of meetings and the far-reaching aspects of Atlantic billfish fisheries, however, renders it impossible for many fishermen to attend meetings. HMS will try to work with fishing organizations and fishermen to schedule meetings at times and in places that are conducive to attracting large crowds. The following list of commercial and recreational fishing industry associations is not comprehensive, but represents organizations that commonly work with NMFS HMS Division. If you would like your association placed on this list, please submit your information to NMFS. Members of the Billfish AP are listed in Appendix B. To be placed on the HMS fax network , please contact Sarah McLaughlin in the Highly Migratory Species Management Division at (301) 713-2347.

Association of Atlantic Fish Spotters
Blue Water Fishermen's Association
Coastal Conservation Association
Commercial Anglers Association
Confederation of Atlantic Coast Charterboat Assoc.
Directed Shark Fishing Association
East Coast Tuna Association
General Category Tuna Association
Green Harbor Tuna Club
Int'l Underwater Spearfishing Association
Jersey Coast Anglers Association
Maryland Saltwater Sportsman's Assoc.
Montauk Boatmen
National Fisherman's Association
New England Harpooner's Association
North Carolina Commercial Fisheries Assoc.
Northeast Atlantic Swordfish Net Association
North Shore Community Tuna Association
Ocean City Charterboat Captain's Association
Ocean City Marlin Club
Recreational Fishing Alliance
Southern Offshore Fishing Association
The Billfish Foundation
Traditional New England Harpooner's Assoc.
United Boatmen of NY/NJ

Table 4.9.1. Personal and participation characteristics of billfish anglers in the eastern United States and Puerto Rico (adapted from Ditton 1996).

Personal and Participation Characteristics	U.S. Atlantic	Puerto Rico (residents)	Puerto Rico (non-residents)
Gender (percent male)	98	97	93
Age (mean years)	46	40	49
Median Household Income	$110,000-$119,000	$70,000-$79,000	$90,000-$99,000
Education (mean years)	16	16	16
Saltwater Fishing Experience (mean years)	26	19	24
Billfish Fishing Experience (mean years)	14	14	16
Annual Frequency (mean days)	39	43	38
Billfish Release Rates (percent)	89	72	87

4.10 Safety of Human Life at Sea

National Standard 10 of the Magnuson-Stevens Act requires that conservation and management measures shall, to the extent practicable, promote the safety of human life at sea. Hazardous situations can not always be foreseen or avoided by commercial and recreational fishermen. Tournament fishing, especially in those tournaments with large monetary rewards, can establish conditions similar to those of derby fisheries and provide the incentive for anglers to jeopardize their personal safety. However, sponsors will generally postpone tournaments if weather conditions are threatening to avoid liability. Also, the vessels which participate in such tournaments are usually large, designed for blue water fishing and operated by professional captains.

Commercial fishing is an inherently dangerous occupation, where fishermen work extremely long hours and are continuously exposed to high risk during transit and while fishing. Professional fishermen identified inexperience, inattention, and fatigue, as the most likely contributors to safety problems (NRC, 1991). However, U.S. Coast Guard casualty data resulting from fishing trips in the Atlantic Ocean and Gulf of Mexico in 1997 illustrate the relatively low rate of casualties in the Atlantic longline fishery. There was one Atlantic longline vessel that sank as a result of a collision (operator negligence) and the three persons on board did not use survival craft (USCG, 1997).

While the primary responsibility for safety resides with the vessel operator, selection of management measures must take into consideration the potential effects on the safety of human life at sea. However, this provision should not adversely affect conservation efforts in other fisheries or discriminate among participants. Fishery management measures may constrain fishermen to fish under conditions that they would otherwise prefer to avoid. This amendment is reviewed by the Billfish AP and Billfish Consulting Parties, including the U.S. Coast Guard, during development of alternatives and regulations, to ensure that fishery mangers recognize any impact on the safety of human life at sea and minimize or mitigate those impacts where practicable. Safety concerns were considered while formulating and evaluating the management measures outlined in this amendment, including mitigating the effects of “derby” fisheries or other situations that result in vessels going out farther, fishing longer, or fishing in weather worse than they generally would have in the absence of management measures, and the safety and stability of fishing vessels when requiring specific gear or requiring the removal of gear from the water.

4.10.1 Fishery Access and Weather Related Vessel Safety

As required by section 303(a)(6) of the MSFCA, this FMP amendment must consider, and may provide for temporary adjustments, after consultation with the U.S. Coast Guard and persons utilizing the fishery, regarding access to the fishery for vessels otherwise prevented from harvesting because of weather or other ocean conditions affecting the safe conduct of the fishery. The following fishery management regulations have raised concerns by the fishermen in that they directly or indirectly pose a hazard to personal or vessel safety under adverse weather or ocean conditions.

4.10.1.1 Safety Concerns

Bycatch reduction management measures include time-area pelagic longline closures in conjunction with the proposed HMS FMP, and reducing commercial pelagic longline bycatch limiting longline gear length and soak time. These measures may affect the operation of fishing vessels and safety risks taken by vessel operators under adverse weather and ocean conditions. Near shore time/area closures may result in fishermen concentrating their fishing effort in areas that are farther than they would ordinarily travel or pursuing fish earlier in the season, in order to maximize their catches before such closures. Both situations could result in greater potential encounters of adverse weather and sea conditions. In the draft HMS FMP, NMFS is proposing to implement limited entry in the Atlantic swordfish and Atlantic shark fisheries. These programs may partially alleviate the fear these fishermen have of not getting a chance to catch their share of the resource, which leads them to risk their safety in derby fisheries.

4.10.1.2 Procedures for Consideration of Management Adjustments

The views of fishery users are obtained by the Highly Migratory Species Management Division through regularly scheduled meetings of the Billfish Advisory Panel and the ICCAT Advisory Committee. In addition, scoping meetings were held for the development of this FMP amendment, as well as from public hearing on this draft FMP Amendment, and pelagic longline workshops. All HMS Consulting Parties are consulted during the public comment period of rulemakings. These Consulting Parties include the Department of State, the U.S. Coast Guard, the ICCAT Commissioners, Fishery Management Councils and other entities listed in the proposed HMS Process (NMFS, 1997).

4.10.2 U.S. Coast Guard Evaluation

The USCG will provide an evaluation of vessel safety issues to be included in this amendment, whether pertinent to fishery access and weather-related safety or to other significant and relevant safety issues in these fisheries.

4.10.3 Flexibility

NMFS will consider providing flexibility to adjust measures for safety concerns to the degree possible (e.g., add weather and ocean considerations as factors to consider in framework measures of time/area closures and commercial gear related regulations).

4.10.4 Procedures

Under the statement of Operating Procedures for the Billfish AP, NMFS may establish a sub-panel of the Billfish AP. For some proposed management measures, this sub-panel would be established in order to monitor, evaluate, and report on the effect of management measures on vessel or crew safety, particularly under adverse weather or ocean conditions.

4.10.5 Other Safety Issues

Safety considerations beyond fishery access and weather-related safety are also considered in this FMP amendment. Increasing the minimum size limits could cause recreational billfish fishermen to go out farther and fish longer in order to take home a legal fish. However, most of these fishermen are not motivated by the landing of fish and engage in catch and release activity which would be unaffected by increased size limits. NMFS encourages fishermen traveling long distances offshore to use monitoring systems such as VMS for safety and communication benefits. Allowing the removal of the hook from fish rather than just cutting the line could lead to additional personal injuries in the process. However, fishermen can still release the fish by cutting the line if they judge that removal of the hook puts their safety at risk. Accidents that can occur on longline vessels involve crew that are hooked and pulled overboard or injured by a "springing" leader resulting from the release of a fish. It is estimated that there are an average of one or two hook-related accidents per year in the pelagic longline fleet. NMFS advises vessel operators to avoid unsafe conditions, have regular U.S. Coast Guard inspections, purchase and maintain safety equipment, educate and train crew members, and be prepared for emergencies.

4.11 Research and Data Needs

One of the required provisions of the Magnuson-Stevens Act for fishery management plans is the assessment and specification of the nature and extent of scientific data and research which are needed for effective implementation of the plan (see §303(a)(8); Appendix A). In the development of this FMP amendment, the following research and data needs were identified. Comments from the Billfish AP, and from the public on the interim billfish rule (63 FR 14030; March 24, 1998) were also considered in identifying these needs.

Estimation of post-release mortality rate. U.S. commercial fishing vessels are required to release all Atlantic billfish, and recreational anglers release approximately 90 percent of all Atlantic billfish that are caught. The survival rates of billfish from these encounters with commercial and recreational gear need to be quantified, and are key components to fully defining the impacts of bycatch in these fisheries. Scientifically designed studies are needed for Atlantic blue marlin, Atlantic white marlin, sailfish and longbill spearfish to quantify the various components of post-release survival, including: handling techniques relative to measuring billfish for compliance with minimum size limits; tagging and hook removal; effects of length of fight prior to release; and impacts of fishing gear (commercial and recreational), including use of circle hooks, and hooks that deteriorate quickly in a saltwater environment.

Gear configurations and fishing strategies. The dead discard of billfish as bycatch from commercial fishing operations is the greatest source of mortality by the United States, as currently reported to ICCAT. Preliminary studies have shown that commercial pelagic longline gear may be configured to reduce the incidence of billfish bycatch. In addition, use of different deployment techniques may further reduce Atlantic billfish encounters with commercial fishing gear. Further research is required to fully describe and quantify possible fishing methodologies that would not impact target catch rates, while reducing billfish bycatch.

Monitoring of recreational effort and landings. The total universe of vessels (private and charter) targeting Atlantic billfish, the quantity of gear used, and the total landings of these anglers is currently not defined. Minimal estimates of landings are currently based on billfish tournament reports and the Large Pelagic Survey. This amendment provides preferred management alternatives to improve monitoring (e.g., charter vessel logbooks and observers), but further research is needed to effectively monitor “rare event” recreational landings like billfish. Development of an effective self-reporting system would allow for the effective use of a landing tag or other similar tracking mechanisms. A standardized reporting methodology to monitor catch and release rates is also needed to assess the amount and type of billfish bycatch in the recreational fishery.

Stock assessment and projections. The next SCRS stock assessment for billfish is scheduled for 1999. A vital research need is an evaluation of the adequacy of the models used in predicting stock recovery rates. The Billfish AP has expressed concern that the models used in this FMP amendment (see Section 2.5.1.3) may be overly optimistic.

Life history studies. The life history of Atlantic billfish are not well defined and research is specifically needed on reproductive parameters (spawning locations, age-specific fecundity and maturity schedules), growth, and natural mortality rates.

NMFS has developed a comprehensive research and monitoring plan to support the conservation and management of Atlantic HMS as required by § 971(i)(b) of the Atlantic Tunas Convention Act (ATCA). This plan is consistent with the legal requirements of ATCA and with the NMFS Strategic Plan (May 1997) and the Strategic Plan for Fisheries Research (February 1998). It was developed after consultation with relevant Federal and State agencies, scientific and technical experts, commercial and recreational fishermen, and other interested persons, public and private. The objective of this comprehensive research and monitoring plan is to ensure that NMFS science is of the highest quality and that it advances the agency's ability to make sound management decisions.

ATCA directs the Secretary of Commerce to develop and implement a comprehensive research and monitoring program to support the conservation and management of Atlantic bluefin tuna and other highly migratory species that shall identify and define the range of stocks of highly migratory species in the Atlantic Ocean, including Atlantic bluefin tuna; and provide for appropriate participation by nations which are members of ICCAT. This research program provides for, but is not limited to:

1. statistically designed cooperative tagging studies;
2. genetic and biochemical stock analyses;
3. population censuses carried out through aerial surveys of fishing grounds and known migration areas;
4. adequate observer coverage and port sampling of commercial and recreational fishing activity;
5. collection of comparable real-time data on commercial and recreational catches and landings through the use of permits, logbooks, landings reports for charter operations and fishing tournaments, and programs to provide reliable reporting of the catch by private anglers;
6. studies of the life history parameters of Atlantic bluefin tuna and other highly migratory species;
7. integration of data from all sources and the preparation of data bases to support management decisions; and
8. other research as necessary.

In developing this program, the Secretary must ensure that the personnel and resources of each regional research center have substantial participation in the stock assessments and monitoring of highly migratory species that occur in the region. The plan shall provide for comparable monitoring of all U.S. fishermen, subject to the authority of ATCA, with respect to fishing effort and the species composition of catch and discards. Finally, ATCA specifies that through the Secretary of State, the Secretary of Commerce shall encourage other member nations to adopt a similar research and monitoring program for Atlantic HMS.

Chapter 4 References

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